NORTHROP VENTURA

NVR-6108

FINAL REPORT

SUMMARY OF ACTION

DESIGN REVIEW ACTION REQUESTS

(NASA-CR-152732) PARACHUTE SUBSYSTEM (ME623-0006-0001). INCREASED CAPABILITY PROGRAM. BLOCK 2 Final Report (Northrop Corp.) 137 p

N77-76311

Unclas
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NVR-6108

FINAL REPORT

- SUMMARY OF ACTION
- DESIGN REVIEW ACTION REQUESTS
- CRITICAL DESIGN REVIEW MEETING OF 13 SEPTEMBER 1967
- APOLLO ELS INCREASED CAPABILITY PROGRAM

November 6, 1967

Distribution:

NAR (15 copies)
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NVR-6108

FINAL REPORT

- SUMMARY OF ACTION
- DESIGN REVIEW ACTION REQUESTS
- CRITICAL DESIGN REVIEW MEETING OF 13 SEPTEMBER 1967
- APOLLO ELS INCREASED CAPABILITY PROGRAM

PARACHUTE SUBSYSTEM
(ME623-0006-0001)

INCREASED CAPABILITY PROGRAM
APOLLO EARTH LANDING SYSTEM
BLOCK II

November 6, 1967

S. O. Lewis, Supervisor
Reliability Engineering

R. P. Wondka
Apollo Chief Project Engineer

Compiled by:
R. J. Flynn
Reliability Engineering

NORTHROP CORPORATION - VENTURA DIVISION
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Newbury Park, California 91320

PROJECT 0107

CONTENTS

1. Introduction

2. Design Review Action Request Summary

3. Northrop Ventura Assigned Design Review Action Request Response

FOREWORD

This document contains the Northrop Ventura reports which were prepared for fullfillment of the design review action requests resulting from the Critical Design Review of the Apollo Increased Capability ELS.

The Critical Design Review meeting was held at Northrop Ventura on 13 September 1967. This activity was accomplished under the authority of Purchase Order M7J7XAZ-470004A, wherein Northrop Ventura is responsible to NAA/SD and NASA, MSC (Prime Contract No. NAS 9-150) for the design, development, qualification, fabrication, test and delivery of parachute subsystems with certain increased capability over the present qualified Block II equipment.

The Apollo Increased Capability Program was necessitated by increases in the design weight of the Apollo spacecraft command module. The Block II Parachute Subsystem had been qualified for recovery of an 11,785 pound command module. The new weight is 13,000 pounds. Analysis of the qualified Block II Parachute Subsystem, relative to the new command module weight, showed that the design was inadequate to insure safe recovery. Certain modifications to the design of the Parachute Subsystem became mandatory.

SECTION 1

INTRODUCTION

On 13 September 1967 a Critical Design Review of the Apollo Increased Capability ELS was held at Northrop Ventura of Newbury Park, California.

Representatives of Northrop Ventura, NAR, NASA, and DCAS who attended the meeting were:

NAME	ORGANIZATION
S. Lewis	NV Reliability
R. Wondka	NV Project Engineer
W. H. Stolz	NAR Recovery System
C. H. Lowry	NAR
R. B. West	NASA MSC
J. W. Kiker	NASA MSC
R. B. Kipp	NV Design Engineer
L. Scrydloff	NV Project Office
J. F. Saunders, Jr.	NASA Headquarters
V. F. Riley	NV Fabric Design
R. J. Boulanger	NV Project Office
T. W. Hughes	NAR/Q&RA Resident Representative
D. L. Beeman	NAR Material
R. W. Keefer	NV Scheduling
W. M. Gran	NV Fluid Dynamics
J. Ruddy	NV Contract Management
D. Gold	NV Fabric Design
R. Meek	DCAS - QAR - NV
B. C. Wayne	DCAS - NV
W. A. Steyer	NV
P. H. Young	NAR/SD
J. O. Powell	NV - Materials Engineering
T. W. Knacke	NV Apollo Staff
J. Ferro	NV Design
J. A. Wells	NV Design
C. H. Utzman	NV Structures
R. Roberts	NV - QC

The meeting consisted of a presentation of:

NAR/SD and NV Objectives

Program Schedules

Specification Requirements and Design Criteria

Mechanical and Fabric Design Description

Laboratory and Field Test Description

and Design Review Action Requests Item Assignments. Thirty (30) Design Review Action Requests resulted from the meeting. A summary of the thirty (30) Design Review Action Requests is presented in Section 2.

SECTION 2

DESIGN REVIEW ACTION REQUEST SUMMARY

DRAR NO.	COMMENT
1-3, 6 (a-e)	Assigned to NAR
4-6 (d, f, g), 7-22, 25(2) 26-30	Response included in Section 3 of this report.
23, 24(2)	Resolved during Critical Design Review Meeting.
24(1), 25(1)	NV to study only if difficulty is encountered during development.

SECTION 3

NORTHROP VENTURA ASSIGNED DESIGN REVIEW ACTION REQUEST RESPONSES

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8127	DUAL REEFING RING	9-13-67	7

SUBMITTED BY: R. WEST
REPRESENTING: NASA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

N.V. CONDUCT COMPARATIVE COST ANALYSIS OF DUAL REEFING RING CONFIGURATION WITH PREVIOUSLY USED DOUBLE RING. THIS ANALYSIS TO FACTOR IN OTHER ACCEPTABLE METHODS OF FABRICATION.
I.E. Forging or Casting.

REASON:
COST REDUCTION

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
N.V. To provide RESULTS OF Evaluation and their recommendations by Oct 2

APPROVALS NAA D E Nuckols SUPPLIER B A Engstrom

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD. DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 81 55	DROGUE CHUTE		8

SUBMITTED BY: WEST — REPRESENTING: NASA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

CONDUCT TENSILE TEST TO DETERMINE EFFECT OF UNEVEN FULLNESS IN INDIVIDUAL RIBBONS RESULTING FROM METHOD OF FABRICATION.

~~TEST SPECIMEN TO INCLUDE~~

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

I	☐	APPROVED - Immediate Action
II	☒	APPROVED - Study
III	☐	REJECTED
IV	☐	NOT APPLICABLE

SCHED/EFFECTIVITY

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION: NV TO INVESTIGATE PRESENT MFG METHODS OF DISTRIBUTING FULLNESS. AND CORRECT IF REQUIRED. NV WILL PROVIDE RATIONAL OF FULLNESS IN HORIZONTALS.

APPROVALS NAA D E Hooker SUPPLIER B A Engleman

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 811D	DROGUE MORTAR		10

SUBMITTED BY: R. WEST — REPRESENTING: NASA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

ANALYSIS DEFINING DROGUE MORTAR MUZZLE VELOCITY REQUIRED TO ACHIEVE BAG STRIP-OFF.

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
NV will provide ANALYSIS by SEPT 18.

APPROVALS NAA R E Thurber SUPPLIER C B Engstrom

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8113	Drogue Mortar Breech Assy		11

SUBMITTED BY: R. West — REPRESENTING: NASA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

INVESTIGATE POSSIBILITY OF DROGUE SABOT - COCKING OR BINDING IN MORTAR AS RESULT OF OFF-CENTER FLOW FROM ERODABLE ORIFICE.

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:

Verification of ~~Hdw~~ Sabot not Binding will be provided by Firing tests Scheduled to start ~~Sept~~ Sept 22

APPROVALS NAA W F Hughes SUPPLIER B A Engstrom

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R-8109	DROGUE STEEL RISER		12

SUBMITTED BY: R. WEST — REPRESENTING:

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

ANALAYSIS OF FACTOR OF SAFETY OF STAINLESS STEEL RISER AND RATIONALE FOR COOKING 600°F / 1 HR - INVESTIGATE EFFECT OF COOKING - REPEATABILITY & Q/C REQMTS

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
NV will provide Letter report by Sept 22

APPROVALS NAA D E Nestler SUPPLIER

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8155	Drogue Riser Assy		13

SUBMITTED BY: John W. Kikta — REPRESENTING: NASA-MSC

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

As a part of Mr Knacke's Drogue Chute riser Action, request change the attachment sewing of riser line when steel cable is attached plus add a keeper

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ○ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
N.V. will revise and submit proposed design by Sept 22

APPROVALS NAA W E Newton SUPPLIER [illegible]

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 805-8	Pack Assy Main		19

SUBMITTED BY: John W. Kiker — REPRESENTING: NASA - MSC

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

Properly color code all three main chute reefing lines, cutters, & cutter pockets

REASON: to prevent mix up in packing operation

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☑ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
NV will have 3 colors of pockets in addition to color coding presently provided.

APPROVALS NAA [signature] SUPPLIER [signature]

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R8155	Drogue Parachute Assy		13

SUBMITTED BY: John U. Kilen — REPRESENTING: NASA-MSC

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

Verify by study changing drogue suspension line from Dyglas to Caesar

REASON:

Weight & volume savings

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:

NV will provide letter report by Sept 29

APPROVALS NAA D E Thacker SUPPLIER A M Martin for Steyer

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
			16

SUBMITTED BY: John W. Kiker — REPRESENTING: NASA-MSC

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

Teflon Coat dual reefing ring

REASON: reduce possible reefing line bag up and burning

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☐ APPROVED - Immediate Action	
II	☒ APPROVED - Study See below	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:

Incorp with DRAR #7

APPROVALS NAA D E Thurber SUPPLIER R Rudolph for Stryker

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8102	MAIN CHUTE REEFING LINE STRENGTH		17

SUBMITTED BY: R. West — REPRESENTING: NASA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

N.V. TO CONDUCT ANALYSIS OF REEFING LINE ~~LOADS~~ TO DEFINE STRENGTH MARGIN.

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ◯ SUPPLIER

RECOMMENDED ACTION:
NV will provide stress data sheet by Oct 2 or before 82-1 if earlier

APPROVALS NAA [signature] SUPPLIER [signature]

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 81-55	DROGUE RISER SLEEVE		18

SUBMITTED BY: R. LOEST — REPRESENTING: NASA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change

PROVIDE METHOD OF SECURING [redacted] ENDS OF RISER SLEEVE TO PREVENT THEM FROM COMING FREE DURING DEPLOYMENT.

REASON: METHOD DESCRIBED APPEARS TO BE SAME AS USED ON BO-5 PILOT RISER. SLEEVES CAME LOOSE AT ON END AND BUNCHED UP ON R

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

I	☒ APPROVED - Immediate Action	SCHED/EFFECTIVITY
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
NU will revise & submit proposed design by Sept 20

APPROVALS NAA [signature] SUPPLIER [signature]

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
RS-8516.17	REEFING CUTTERS		19

SUBMITTED BY: R. West — REPRESENTING: NASA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

N.V. TO PROVIDE STUDY DEFINING ALLOWABLE REEFING CUTTER TOLERANCES RELATIVE TO PARACHUTE LOADS.

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ○ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
N.V. will incorporate in report of total reefing system. & Submit by ~~Sept~~ Oct 2

APPROVALS NAA D E Hawkins SUPPLIER W. Mendenhall for Steger

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
B7541	Main Parachute.		20

SUBMITTED BY: John W. Kiker — REPRESENTING: NASA-MSC

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

Defin by analysis & test main chute safety factor & loads. in event of 2nd stage reefing line failure - conduct analysis first

REASON: Design requirement

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☐ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION: NV to Submit letter report by Oct 2

84-1 Test Scheduled Mid October

APPROVALS NAA D E Hasler SUPPLIER M M Madhavan Steyer

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R8155-1	DROGUE Parachute Assembly	9/13/67	1

SUBMITTED BY: W. M. GRAN
REPRESENTING: Northrop-Ventura

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

Northrop Ventura is presently using 143.2 inches as one Command Module Hydraulic Diameter. The drogue parachute is positioned 6 hydraulic diameters aft of the CM.

It is suggested that NAA/SD either varify the hydraulic diameter number that NV is using or specify a more correct number based on present CM aerodynamics for Entry and Abort Conditions

REASON:

~~To permit calculation of drogue pendant riser length~~
TO ASSURE CORRECT CALCULATION OF RISER LENGTH

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☐ APPROVED - Immediate Action	
II	☒ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ⊗ NAA ⬡ SUPPLIER

RECOMMENDED ACTION:
NAA To Provide Correct Design Interface Information, By Oct 13. N.V. to proceed using Present assumptions.

APPROVALS NAA D E Archer SUPPLIER B A Singleton

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
NAA. MC 901-0579 "D"		9/12/67	2

SUBMITTED BY: W. M. GRAN
REPRESENTING: Northrop Ventura

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

New aerodynamic coefficients have recently been developed. It is requested that Specification MC 901 0579 D. be modified to include these new values.

REASON:

To permit calculation of dynamic pressure at Pitot Static Fins and at main chute line attach. Permit calculation of riser abrasion Later item urgent, and along apparent need for this data. Criteria

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☐ APPROVED - Immediate Action	
II	☒ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ⊗ NAA ○ SUPPLIER

RECOMMENDED ACTION:

NAA will review NASA data & implement as appropriate by Oct 13

APPROVALS NAA D. E. Parker SUPPLIER B. A. Singleton

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
AA ME 623-0006 A		9/13/67	3

SUBMITTED BY: L. SCRYDLOFF
REPRESENTING: NORTHROP VENTURA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

REVISE NOTED SPECIFICATION TO REFLECT USE OF 2 CUTTERS PER REEFING LINE ON MAIN PARACHUTE. & ADD REQUIREMENT FOR REDUNDANT REEFING IN FIRST STAGE.

REASON: UPDATE TO AGREE WITH PRESENT NV DESIGN.

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ⊗ NAA ○ SUPPLIER

RECOMMENDED ACTION:
Change will be included with change relieving Constraint to use present 5 48 sec. cutters.
Est. Date Oct 13

APPROVALS NAA W E Mackey SUPPLIER B A Engstrom

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R5155	DROGUE CHUTE		4

SUBMITTED BY _____ REPRESENTING _____

DISCUSSED WITH:

NAME	ORGANIZATION
T.W. Knocke	N.V

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

CONDUCT STRENGTH TESTS ON FOLLOWING CANOPY JUNCTION POINTS:

1. HOR. RIBBON - VERT RIBBON: STRENGTH IN BOTH DIRECTION.
2. HOR. RIBBON - RADIAL RIBBON: STRENGTH IN BOTH DIRECTION

Junction should duplicate finished items including hot needle tags and sewing.

REASON:

To investigate strength degradation due to hot needle tacking and sewing.

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ○ NAA ⊗ SUPPLIER

RECOMMENDED ACTION: Run test excluding joints without Hot tacking with present hot tacking and with reduced number of Hot tack points. Completion by 13 Oct.

APPROVALS NAA D E Parker SUPPLIER C B Eggleston

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8155	DROGUE CHUTE RISER (-115)		5

SUBMITTED BY _____ REPRESENTING _____

DISCUSSED WITH:

NAME	ORGANIZATION
T.L. Knacke	NV

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

Investigate suspension line - riser keeper (-115) (-121) efficiency (2 places)

a. test individual susp. line efficiency

b investigate redesign for better efficiency

REASON: Present keeper fail serving accumulation on 2lg-2ag and horizontal seam stitching resulting in poor efficiency

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ⬡ NAA ⬡ SUPPLIER

RECOMMENDED ACTION: NV to prepare special MS calculations for NAA/SD use, based on complete degradation tests of subject keeper. Complete in 2 weeks. Redesign if MS is negative. ~~Control~~ Mfg ~~to support of program clients delay to assure proper stitching.~~ of risers limited inventory.

APPROVALS NAA D.C. Beckler SUPPLIER C.A. Eggleston

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
MC 901-0579 D		9/13/67	6

SUBMITTED BY: Worden — REPRESENTING: NV

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

REVISE MC SPEC a) TO INCLUDE RATED HYDRAULIC DIA

define policy dynamic tests in non-chute test

b) TO INCREASE DROGUE RETENTION LOAD TO 13,500# LIMIT & SPECIFY 3σ METHOD FOR DETERMINATION

specify 3σ calculations do not apply to determination of readings to the CAI (43,400#)

c) REVISE END POINT q TO 70 psf (ON DROGUE)

d) ADD 2 BONDING HOLES TO DROGUE MORTAR TO MATCH R8108-1, ELIMINATE EXISTING CALLOUT IN MC SPEC

REASON:

e) ADD BURST VALUE & DESCRIPTION OF BURST TO MC SPEC FOR DROGUE PRESSURE VESSELS

FILL VOID IN NAA/SD REQMTS.

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☐ APPROVED - Immediate Action	
II	☒ APPROVED - Study & As Noted	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

SEE ITEM F & G

ACTION REQUIRED BY: ⊗ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:

e) NAA will incorp in next revision.

(a) See DRAR #1
(b) HOLD PENDING FIRING TEST DATA, 3σ will be incorporated.
(c) See Disposition on DRAR #1 & 2
(d) Spec will be changed to call out 1 hole - Furthest from cable slot.
(e) ~~[illegible]~~
(f) ~~DRAR will cover by REVIEW AND APPROVAL OF THIS END ITEM SPEC~~

APPROVALS NAA A.S. Hughes SUPPLIER B.A. Engholm

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO	PART NAME	DATE	DRAR NUMBER
DROGUE CHUTE	LAYOUT TABLE	9-13-67	9

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

CHECK & REPLACE ALL WIRE NAILS HAVING SHARP HEADS (ON UNDERSIDE) USED FOR LOCATING RIBBONS DURING TACKING PROCESS

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
NV WILL REMOVE ANY SHARP PROTRUSIONS AND OTHER ~~DETRIMENTAL~~ POSSIBLE OR POTENTIAL DAMAGE CAUSING AREAS

APPROVALS NAA W E Mueller SUPPLIER B A Engelson

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO	PART NAME	DATE	DRAR NUMBER
R8122/R8120		9-13-67	21

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. REVISE CLEVIS OR ~~TUBE~~ BUSHING DIMENSIONING. BUSHING CAN BE .030 SHORT WITH PRESENT TOL.

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☑ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:

Will comply

APPROVALS NAA D. F. Hacker SUPPLIER W. Rodd for W. Steiger

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R8109	RISER ASSY DROGUE METAL	9-13-67	22

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. 040R INTERFERES WITH CHAMFER ON R8120
2. 040R ON OPPOSITE END FITTING IS OUT OF ENVELOPE
3. ADD PROOF LOAD

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ◯ SUPPLIER

RECOMMENDED ACTION:
NU will correct

APPROVALS NAA D E Hughes SUPPLIER A A Roth for Styer

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8124	TUBE, DROGUE MORTAR (ROUGH)	9-13-67	22

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. ADD GRAIN FLOW DIRECTION AND/OR CALL FOR BLOCKER DIE FOR BETTER PROPERTIES AND LESS MACHINING.

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☐ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☒ NOT APPLICABLE	

ACTION REQUIRED BY: ◯NAA ◯SUPPLIER

RECOMMENDED ACTION:

NV stress analysis takes random grain orientation into account

APPROVALS NAA D. E. Meeker SUPPLIER R. M. Roth for Stoltzer

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R8113A	BREECH, DROGUE MORTAR	9-13-67	24

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. CHANGE TO INCONEL 718 TO ELIMINATE PLATING & PROVIDE BETTER LO TEMP CHARACTERISTICS.
2. ADD COUNTERSINKS TO ALL TAPPED HOLES

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

			SCHED/EFFECTIVITY
I	☐	APPROVED - Immediate Action	
II	☐	APPROVED - Study	
III	☒	REJECTED see notes.	
IV	☐	NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ◯ SUPPLIER

RECOMMENDED ACTION:
ITEM 1 STUDY IF DIFFICULTY IS ENCOUNTERED IN DEVEL.
ITEM 2 COVERED BY STD SHOP PRACTICE SPEC.

APPROVALS NAA D E Hunter SUPPLIER [illegible]

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R8114	RESTRICTOR, DROGUE MORTAR	9-13-67	25

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. REPLACE A340 WITH INCONEL 718
2. SHOW -9 INSERT PROTRUDING SO THEY WONT BE CUT OFF AFTER INSTAL.

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

I	☒	APPROVED - Immediate Action
II	☐	APPROVED - Study
III	☐	REJECTED
IV	☐	NOT APPLICABLE

SCHED/EFFECTIVITY

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:
ITEM 1 STUDY ONLY IF DIFFICULTY encountered during devel.
ITEM 2. will eliminate -9 insert & use Lock-Ite on parts made OK Basis.

APPROVALS NAA R E Parker SUPPLIER [illegible] Stolz

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R8119	COVER, DROGUE MORTAR	9-13-67	26

SUBMITTED BY: W. STOLZ — REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. REPLACE DIMS 1.150 & 1.770 WITH ONE (1) EDGE DISTANCE DIM

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:

NV will re-dimension to reduce one or more dimensional call outs

APPROVALS NAA [signature] SUPPLIER [signature]

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8108/R8111	DROGUE SHEAR PIN	9-13-67	27

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. COORDINATE DIMENSIONING OF GROOVE ON R8111 WITH WALL THICKNESS ON R 8108

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊘ SUPPLIER

RECOMMENDED ACTION: Item 8
Refer to DAR 29, to assure proper match

APPROVALS NAA D.E. Richter SUPPLIER Worthington Styer

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8128	NUT ASSY DROGUE RISER	9-13-67	08

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. REVISE METHOD DIMENSIONING BY REPLACING .125 WITH .295 FROM OTHER END TO IMPROVE TOL CONTROL.

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	☒ APPROVED - Immediate Action	
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:

NV will revise dimensions to allow Tol build up or loss of flange not threads. NV will advise if this results in critical condition.

APPROVALS NAA D E Merkin SUPPLIER Walther / Steyer

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
R 8108	TUBE DROGUE MORTAR	9-13-67	29

SUBMITTED BY: W. STOLZ
REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

1. ADD MATCH NOTE FOR 6 INSERTS (MATCH R8113)
2. DIMS 6.994 & 10.616 CAN'T BE MEASURED. CHANGE TO REF OR CODE FOR TOOLING INFO.
3. DIM 9.284/9.278 SHOULD BE CODED CRITICAL.
4. ADD COUNTERSINKS FOR TAPS
5. TWO 7/32 DIA HOLES NOT PER SCD
6. ADD CODE (M) TO .060 MIN (WALL)
7. REPLACE HELICOIL INSERTS WITH KEENSERTS OR EQUIV.
8. CLARIFY DIMENSIONING OF UPPER END (12.260 MAX, 12.125/12.135 ID, 060 MIN)

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

		SCHED/EFFECTIVITY
I	[X] APPROVED - Immediate Action	
II	[ ] APPROVED - Study	
III	[ ] REJECTED	
IV	[ ] NOT APPLICABLE	

ACTION REQUIRED BY: ( ) NAA ( ) SUPPLIER

RECOMMENDED ACTION:

1 THRU 6 NV will incorp.

7. NAA will recheck usage of Helicoil with or w/o Locktight. Answer by Sept 22
8. NV will clarify to assure sufficient wall thickness at upper end

APPROVALS NAA D E Richey SUPPLIER [signature]

ENG-A-590 EXPIRES 5-65

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

DESIGN REVIEW ACTION REQUEST

(Applicable information shall be completely filled in)

PART NO.	PART NAME	DATE	DRAR NUMBER
			30

SUBMITTED BY: C. H. Lowry — REPRESENTING: NAA

DISCUSSED WITH:

NAME	ORGANIZATION

RECOMMENDED CHANGE (Make complete, concise statements. Use separate sheet for each change.)

NAA APPROVES THE FOLLOWING DRAWINGS IN ACCORDANCE WITH CDR PROCEEDINGS

R8110-1 (EXCEPT N/A CALLS OUT ONLY 1/END ITEM)
R8107-1
R8117-1
R8118-1
R8121-1
R8123-1
R8157-1
R8156-1
DR8115-1 } APPROVED PROVIDING R DWG IDENTICAL TO THESE REVIEW COPIES
DR8112-1 }

R8108 — (approved unless NV is notified in 7 days) and provided upper end wall thickness is clarified & provided DRR 29, 1-6, are incorporated.
R8113A
R8114 — (provided — 9 insert is eliminated)
R8119 — (provided shear hole dimensions are revised to reduce one call out.)
R8128 — (provided dimensions are revised)

REASON:

SUBMITTER DO NOT WRITE BELOW THIS LINE

BOARD DECISION

I	☐ APPROVED - Immediate Action	SCHED/EFFECTIVITY
II	☐ APPROVED - Study	
III	☐ REJECTED	
IV	☐ NOT APPLICABLE	

ACTION REQUIRED BY: ◯ NAA ⊗ SUPPLIER

RECOMMENDED ACTION:

NV TO RE-SUBMIT DR8115-1 & DR8112-1 AS "R"S. (to these approved dwgs) Changes thenceforth shall be three EDCP procedure

APPROVALS NAA D E Hucker SUPPLIER [illegible]

ENG-A-590 EXPIRES 5-65

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 4

Part Number: R8155

Part Name: Drogue Chute

Recommended Change:

Conduct strength tests on following junction points:

1. Horizontal ribbon - Vertical ribbon; strength in both directions.
2. Horizontal ribbon - Radial ribbon; strength in both directions.

Junctions should duplicate finished items including hot needle tacks and sewing.

Reason:

To investigate strength degradation due to hot needle tacking and sewing.

Action:

Test samples have been designed in accordance with the subject recommended change. Samples are of horizontal/vertical junctures suitable for pulling in either direction and horizontal/radial junctures also suitable for pulling in either direction, these samples are being fabricated using no heat tacks in one set, a minimum of heat tacks in the second set, and "standard" heat tacks in the third set.

Are there any conclusions?

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 5

Part No.: R8155

Part Name: Drogue Chute Riser

Recommended Change:

Investigate suspension line-riser keeper efficiency (2 places).

a. Test individual suspension line efficiency.

b. Investigate redesign for better efficiency.

Reason:

Present keeper has sewing accumulation on zig-zag and horizontal seam stitching resulting in poor efficiency.

Action:

Two new approaches to the keeper design have been taken. Details of these new keeper designs are shown on the attached figures.

The first configuration (Figure 1) initiated a ring-type fabric keeper design attached to the riser by a cord loop inserted into the riser lines. The characteristic of a chinese finger with zig-zag stitching retained the loop.

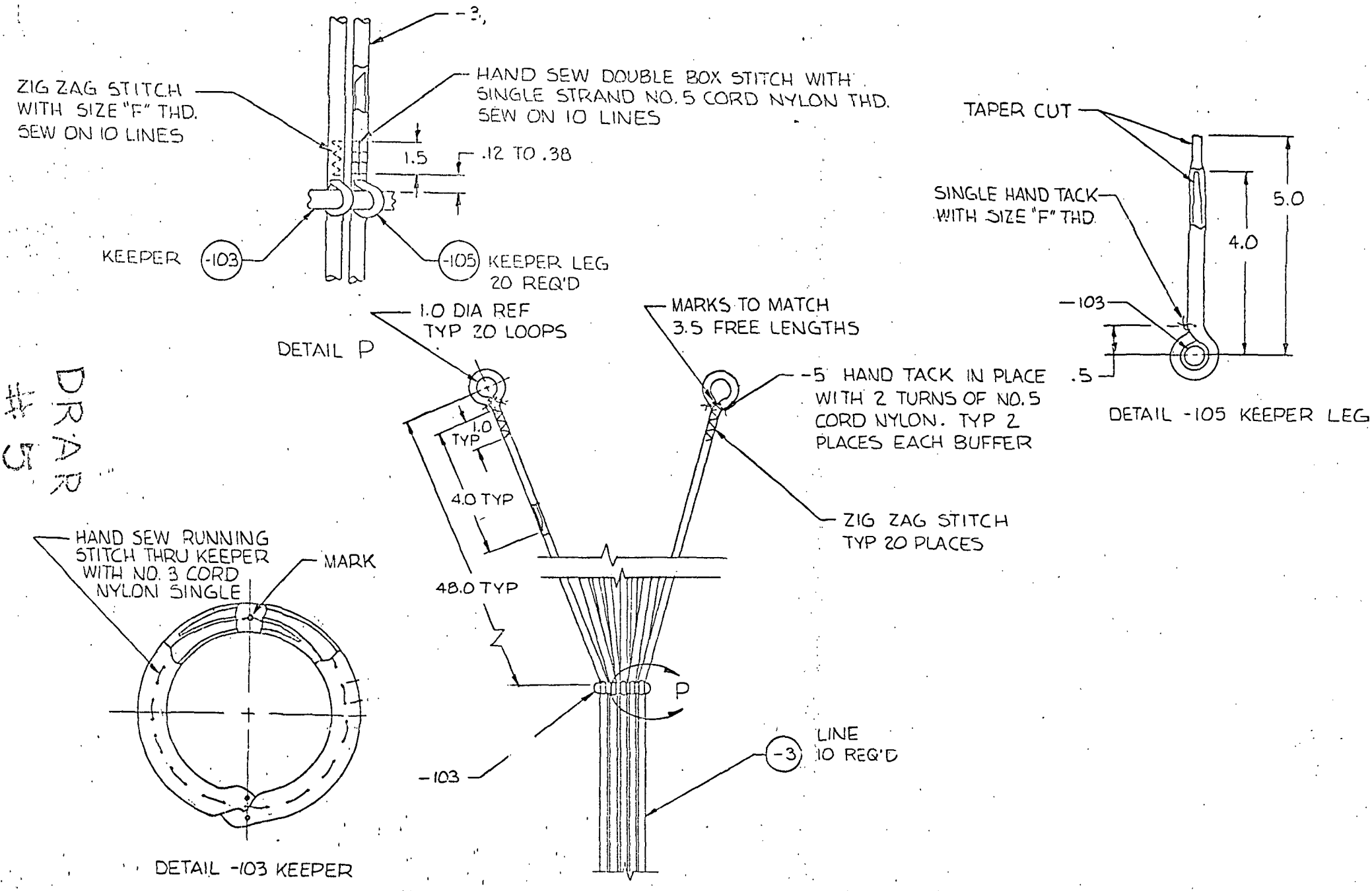
Individual pull tests (MLTR No. 5402) of each line and complete riser assembly tests (TP No. 6251) showed a considerable improvement over the original design and exceeded the limit design load required. It showed sufficient margin for the first PTV drop test, but fell below the pass/fail load criteria required for the ultimate design.

The second configuration (Figure 2 and 3) retained the above fabric ring keeper design but held it in place by insertion of a line into the riser above and below the keeper. The designs shown on Figures 1 and 2 are identical except that Figure 1 uses 1550 lb dacron line and Figure 3 uses 2000 lb nylon line.

Individual test specimens of the second configuration with 1550 lb dacron line (Figure 2) were tested (MLTR No. 5425) and proved to be 93% efficient. Wide scatter in the test results and the material control samples (MLTR No. 5408) indicate a loss in efficiency due to the material.

Individual test specimens of the second configuration with 2000 lb nylon line (Figure 3) were tested and proved to be 98% efficient. A small scatter in the test specimens and the material control samples was recorded. Complete riser assemblies are to be tested, additional details of which will be covered in the EDCP.

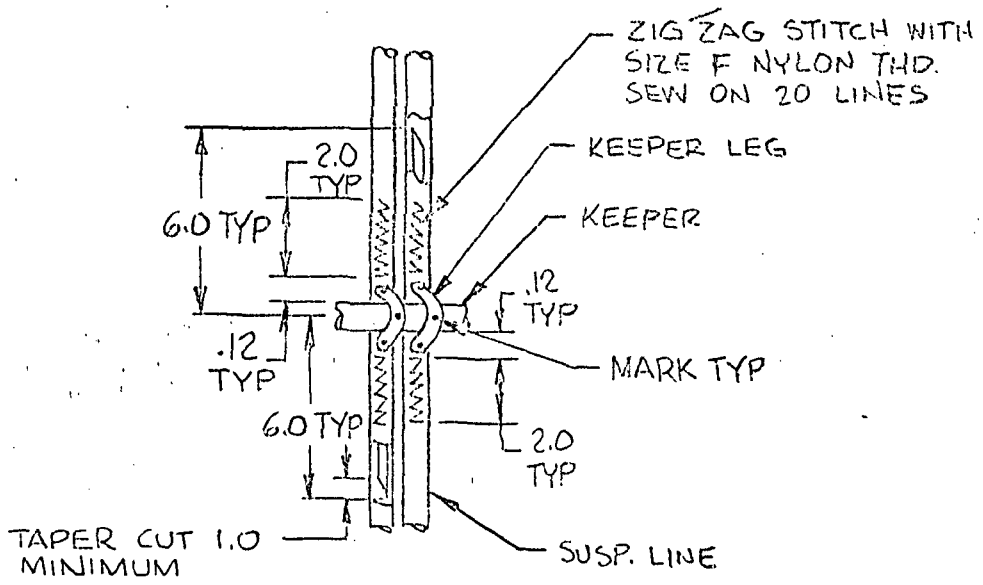
Not completely satisfactory. Suggest loop per Fig 1 with thimbles finger above & below each other instead of parallel.

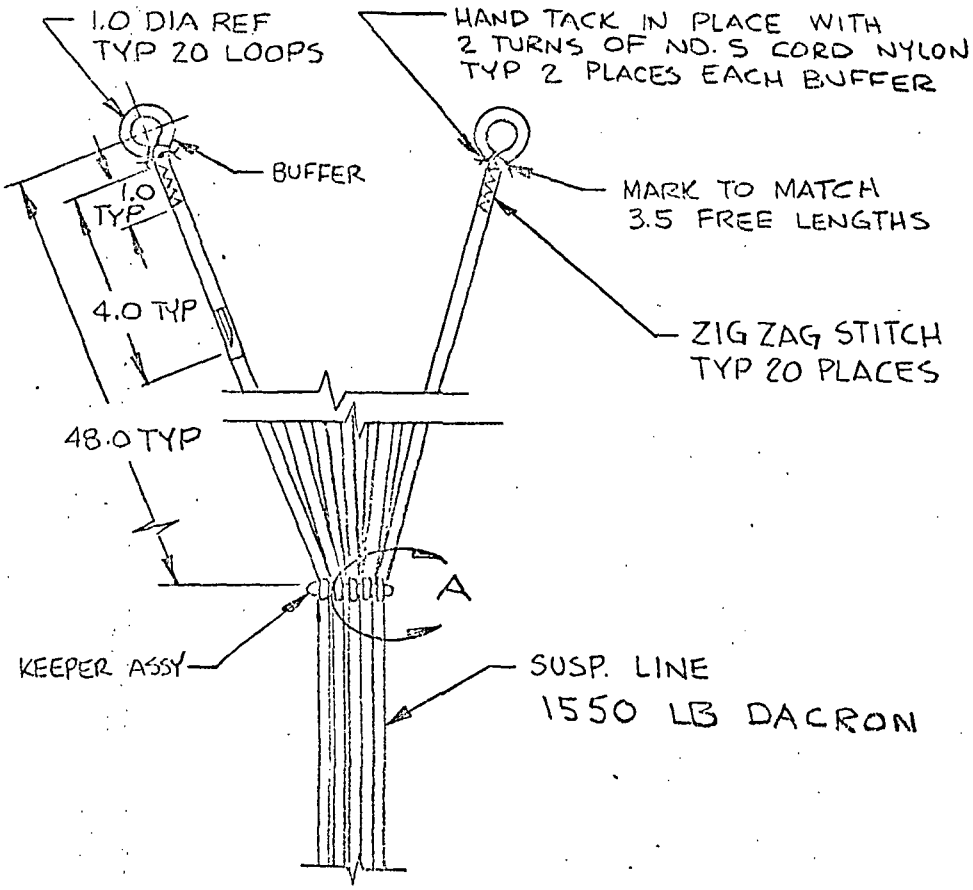


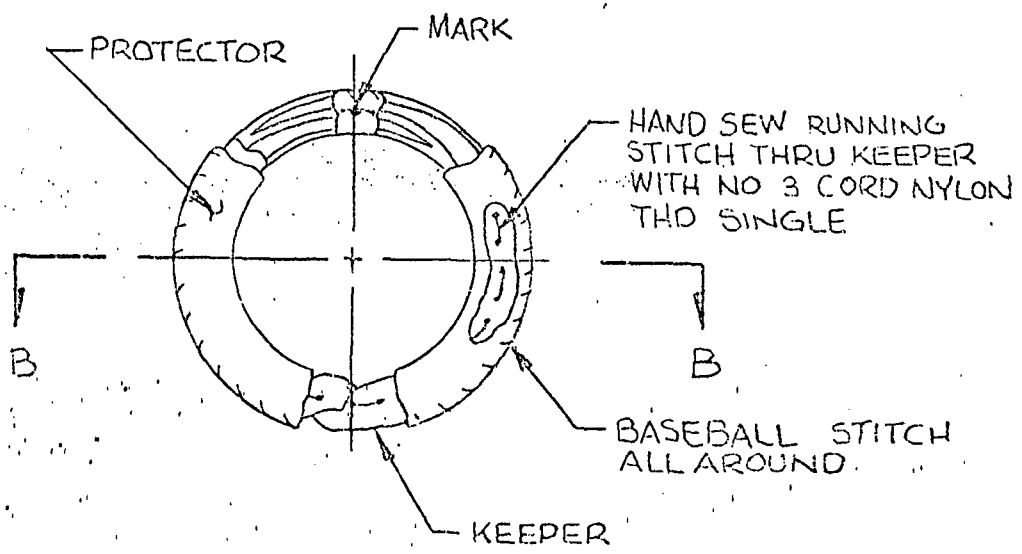
DRAR #5

FIGURE 1

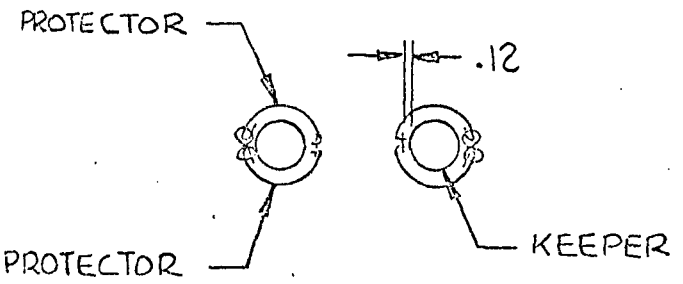
DROGUE KEEPER





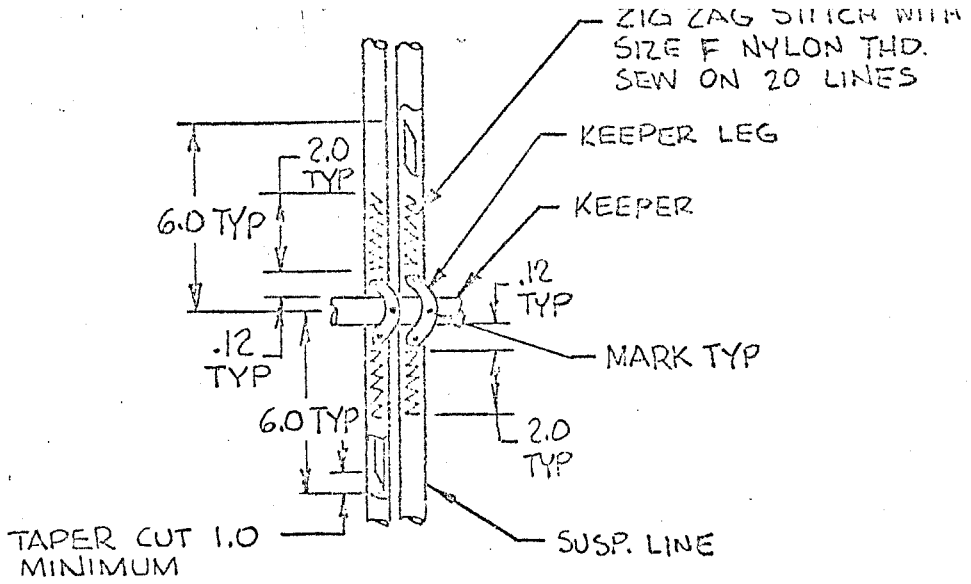


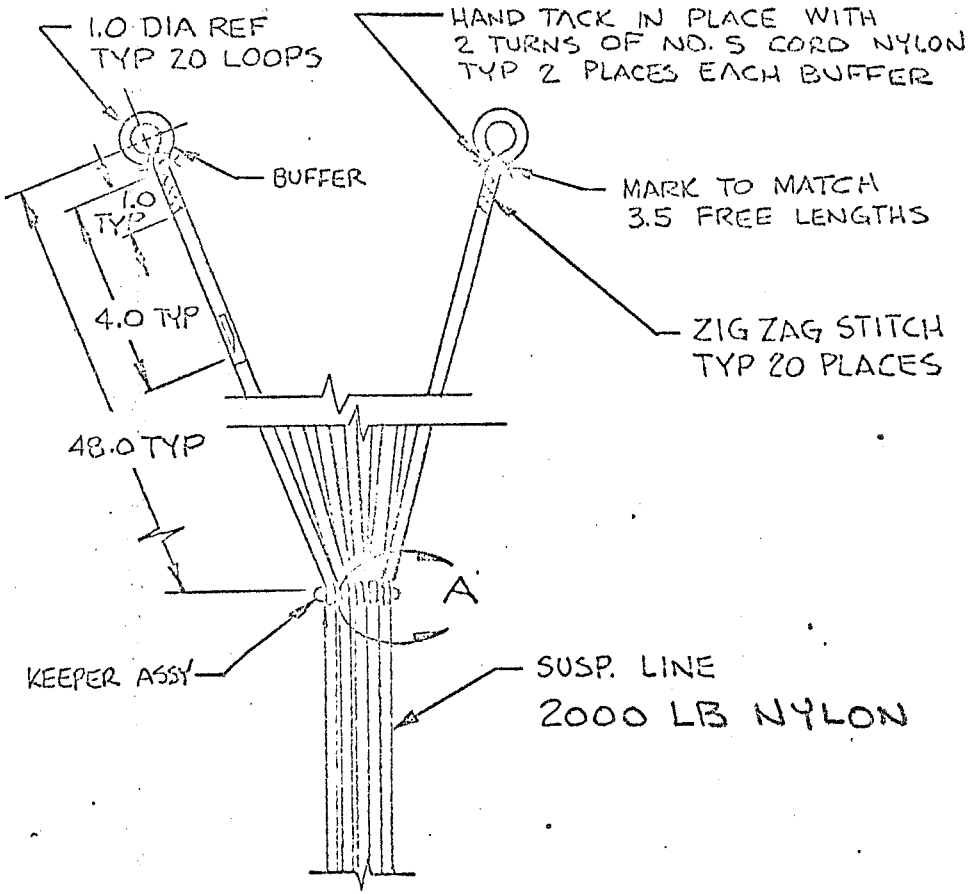
DETAIL KEEPER ASSY

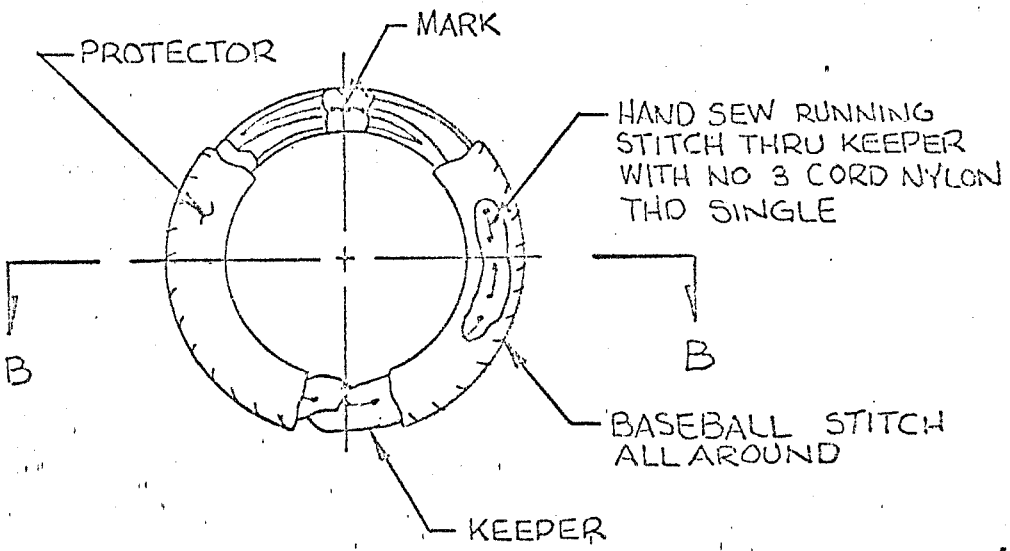


SECTION B-B

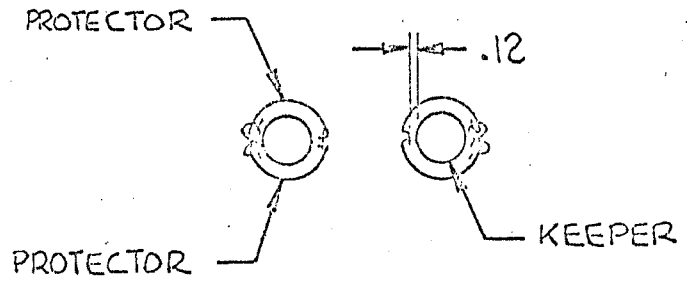
FIGURE 2







DETAIL KEEPER ASSY



SECTION B-B

FIGURE 3

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 6(d)

Recommended Change:

Remove one (1) hole for bonding strap from flange of drogue mortar tube.

Reason:

Only one electrical bonding hole is required.

Action:

Drogue mortar tube drawing number R8108 was revised by ADCN A7. This drawing change deleted the specified hole and specified a method of reworking existing parts.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 6(f) and 6(g)

Recommended Action:

Define policy, dynamic factors in main chute loads and specify 3 sigma calculations do not apply to determination of loadings to the CM (43,400#).

Reason:

Clarification of design requirements.

Action:

Change to End Item Specification SS-00003 have an estimated completion date of November 7, 1967.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 7

Recommended Change:

Conduct a comparative cost analysis of forging versus casting fabrication of the dual reefing ring configuration and previously used double rings. The analysis shall factor in other acceptable methods of fabrication.

Reason:

Potential cost reduction.

Action:

The attached value analysis summary includes an evaluation for both DRAR 7 and 16. This analysis recommends a teflon coated investment cast dual ring. An engineering drawing of the recommended configuration has been completed and is scheduled for release November 8, 1967.

VALUE ANALYSIS SUMMARY

V.A.R. No.

V.S. No. 47001

(VALUE ASSURANCE IMPROVEMENT STUDY)

UNIT DESCRIPTION Reefing Ring END ITEM Apollo Main Chute

REQUESTOR R. J. Boulanger ORG 2150 DATE IN 9/21/67

REQUESTED ACTION: Cost Analysis Reefing Ring.
Conduct comparative cost analysis of dual reefing ring configuration with previously used double ring. The analysis is to factor in other acceptable methods of fabrication.

VS PLANNING REVIEW BY J. R. Vickers DATE 9/21/67

REQUEST DISPOSITION: ☒ ACCEPT FOR STUDY ☐ NOT ACCEPTED

VALUE ANALYSIS SUMMARY; FUNCTION, ALTERNATE DESCRIPTIONS, EVALUATION OF ALTERNATE PERFORMANCE, COLLATERAL COST CONSIDERATIONS, IMPLEMENTATION CONSIDERATIONS, RECOMMENDATION, & ANALYSIS PARTICIPANTS.

The following methods of fabrication of the reefing ring were evaluated:

	Methods	Disposition
1.	Purchase Dual	Current Method -- High cost
2.	Purchase single (double)	Previous Method -- Medium cost - customer change
3.	Investment cast Dual	Consider for use - low cost
4.	Investment case single	Eliminated - customer preference dual
5.	Injection mold dual	Possible - medium cost
6.	Injection mold single	- Eliminated - customer preference dual
7.	Extrusion - dual	- Eliminated - high cost
8.	Forging	- Eliminated - high cost

Sources contacted for informal prices and general data:

Investment Casting - Golden State Casting - 9313 Borden Ave, Sun Valley - Mr. Fehr

Injection Mold - Crescent Mold - 11619 Pendleton, Sun Valley - Mr. Flynn

ϕ COST COMPARISONS: ☐ Comparative ☐ Complete UNITS PER E/I Col I

	ALTERNATES ⊗ Indicates V.E. Preference	COL I	NON-RECURRING TOTAL COSTS		AVERAGE COST PER END ITEM RECURRING			* TOTAL
			TOOLING	OTHER	MATERIAL	OFFSITE	LABOR	
1	Present Dual Ring	dual-76				513.00		515.48
		single-4				2.48		
(X) 2	Dual Investment Cast	dual-76				87.40		89.88
		single-4				2.48		
3	Dual Injection Mold	dual-76	600.00			32.68	76.00	111.16
		single-4				2.48		
4	Investment Cast Single	156	630.00			93.60		93.60

* TOTAL COST INCLUDES RECURRING & AMORTIZED NON-RECURRING COSTS FOR 60 E/I

The 4 single are current rings purchased at 62¢ each

ϕ NOTE. Elements common to alternates may have been deleted. Costs may be comparative and not complete costs.

R. P. Davidson 2212 569 10/3/67 [signature]

VALUE ENGINEER ORG EXT DATE APPROVAL

TEMP. FORM 1400-C2

VALUE ANALYSIS SUMMARY

(VALUE ~~ASSURANCE~~ IMPROVEMENT STUDY)

V.A.R. No.

V.S. No. 47001

UNIT DESCRIPTION Reefing Ring END ITEM

REQUESTOR R. J. Boulanger ORG DATE IN 9/21/67

REQUESTED ACTION: Teflon coat Dual Reefing Ring. Reduce possible Reefing Line hang up and Burning

VS PLANNING REVIEW BY J. R. Vickers DATE 9/21/67

REQUEST DISPOSITION: ☒ ACCEPT FOR STUDY ☐ NOT ACCEPTED

VALUE ANALYSIS SUMMARY; FUNCTION, ALTERNATE DESCRIPTIONS, EVALUATION OF ALTERNATE PERFORMANCE, COLLATERAL COST CONSIDERATIONS, IMPLEMENTATION CONSIDERATIONS, RECOMMENDATION, & ANALYSIS PARTICIPANTS.

To reduce possible burning and hang up of the Reefing Line.

	Method	Disposition
1.	Anodize	Current method - low cost
2.	Alodine	Eliminated - increase coefficient of friction
3.	Dense Chrome	Eliminated - high cost
4.	Electrolize	Eliminated - high cost
5.	Hard anodize	Consider for use - 2nd V.E. Preference - medium cost
6.	Teflon	Consider for use - 1st V.E. Preference - medium cost

Sources contacted for informal prices and general technical data.
Teflon - Bradstrong Co. 1570 E. Walnut St., Pasadena - Mr. Truman
Hard Anodize - Sandia Co - 15519 Lauark St., Van Nusy - Mr. Cohen

To increase the reliability of the Reefing Rings and Reefing Line an added cost of $14.28 is required per end item. Total increase for 60 E/I is $856.80.

$ COST COMPARISONS: ☐ Comparative ☒ Complete UNITS PER E/I 80

	ALTERNATES ⊘ Indicates V.E. Preference		NON-RECURRING TOTAL COSTS		AVERAGE COST PER END ITEM RECURRING			* TOTAL
			TOOLING	OTHER	MATERIAL	OFFSITE	LABOR	
1	Anodize					.07		5.60
2	Hard Anodize					.25		20.00
3	Teflon					.25		20.00

* TOTAL COST INCLUDES RECURRING & AMORTIZED NON-RECURRING COSTS FOR 60 E/I

$ NOTE. Elements common to alternates may have been deleted. Costs may be comparative and not complete costs.

R. P. Davidson	2212	569	10/3/67	
VALUE ENGINEER	ORG	EXT	DATE	APPROVAL

Value Analysis Summary 47001 (Continued)

Request -

A producibility study of the reefing rings with comparative cost of previously used single rings, current dual rings and other methods of fabrication. Incorporate in the study, a trade-off evaluation of coating processes to increase the reliability of the reefing rings and line.

Function -

Guide and restrain Reefing Line

Information -

1. Quantity

   The study was based on 60 end items with each end item using 76 dual rings and 4 single rings. The total quantity for the 60 end items are 4560 dual and 240 single rings.

2. Present cost data

   The current dual ring is purchased complete at a cost of $6.75 each on a 1000 lot purchase order. Per estimating the single ring cost is 62 cents each.

3. Obsolescent

   The manufacturing planning section stated that 2200 of the dual rings are ordered and are being delivered, this quantity will last for 8 weeks. The single ring is a NV standard part which will be utilized on the proposed alternate method. This data indicates that no obsolete rings will result from the implementation of the proposed method.

Speculation --

1. Alternate methods of fabrication

   a. Investment casting

   b. Injection molded rings

   c. Extrusions

   d. Forgings

   e. Stampings

   f. Manufacturing methods

   g. Die, permanent mold and shell molding castings

2. Alternate coating process

   a. Alodine

   b. Anodize

   c. Electrolize

   d. Teflon

   e. Dense Chrome

   f. Chrome

   g. Hard Anodize

Analysis

1. Producibility

   The evaluation of the alternate methods of fabrication showed that the dual investment casting was the best method.

   An informal quotation of a $600.00 die charge and a 95¢ casting price was obtained on the 4560 quantity needed for the 60 end items. The delivery of the rings has a 4 week lead time for tooling and a 3 week lead time for production castings after approval of 1st article. Production rate of the castings will be approximately 500 per week.

   The informal quotation with delivery rate was obtained from Mr. Dick Fehr, Golden State Casting Co., 9313 Borden Ave., Sun Valley, California.

   This information quotation should be substantiated with a formal quotation by the Purchasing Branch.

2. Teflon Coating process

   The evaluation of the processing method indicated that the Teflon coating process was the best approach.

   An informal quotation of 25¢ per ring was obtained on 4560 dual and 240 single rings. Also a quotation of $32.00 lot price to Teflon coat one end item, 76 duals and 4 single, if required for test purposes.

These quotations were obtained from Mr. John Truman, Bradstrong Co., 1570 East Walnut Street, Pasadena, California.

This informal price should be formalized by the Purchasing Branch.

Saving Summary:

A summary of the savings, cost-saving ratio and percentage of reduction is as follows:

Present cost - 60 end items - dual ring	$30,780.00
Proposed cost - 60 end items dual ring	5,244.00
	$25,536.00
V.E. Study 68 hrs @ $20.00/hr (est)	1,360.00
	$ 24,176.00

Implementation Cost

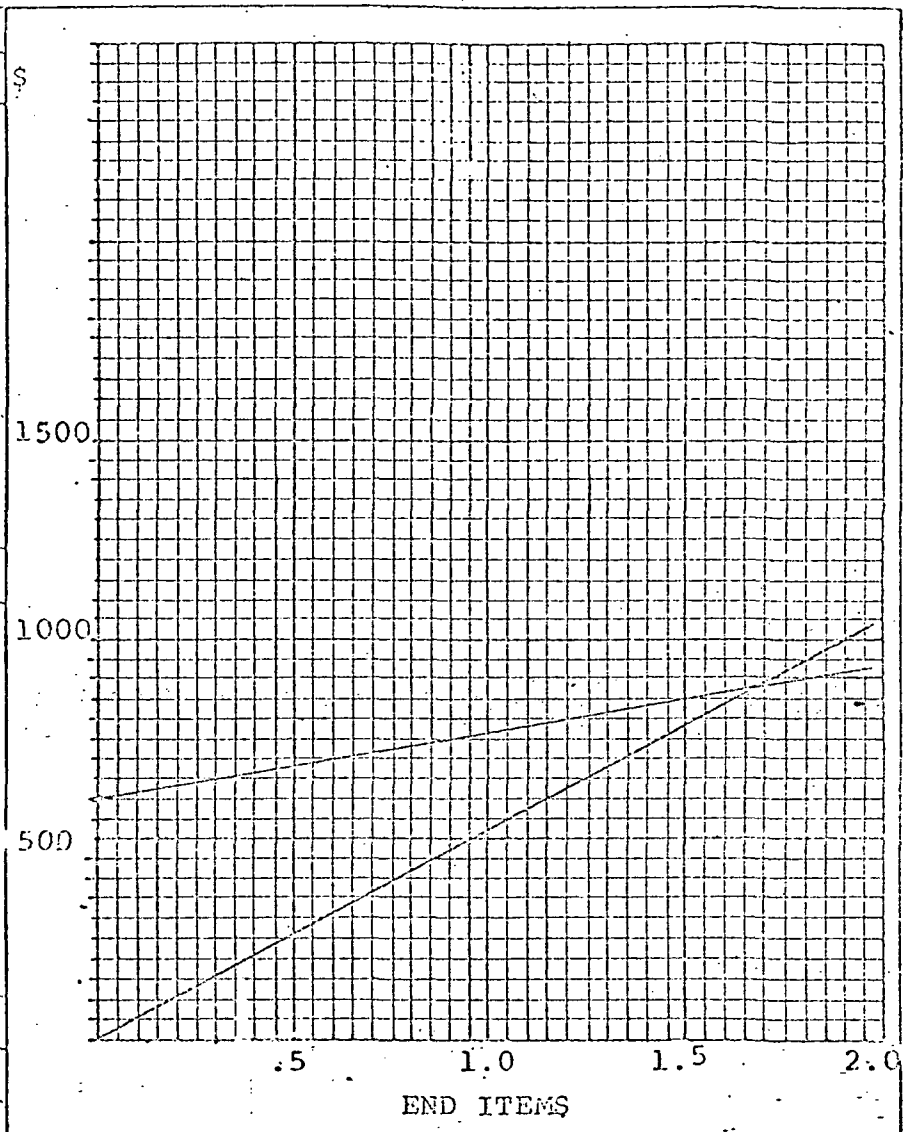
Blue print charge 20 hrs @ 20.00/hr (est)	$400	
Paper work and handling 10 hrs @ 15.00/hr (est)	150	
Miscellaneous expense (est)	450	1,000.00
		$ 23,176.00
Added cost of teflon to increase reliability		856.80
Net Savings		$ 22,319.20

Percentage of cost reduction 72%

COST SUMMARY

HOW MUCH WILL THAT COST?

'-RECURRING	IMPLEMENTATION COST	
	PRESENT	PROPOSED
		600.00
ıortized		
8-TOTAL		.13
ECURRING		
ırchase Part	6.75	
ısting		.95
ıodize		.07
8-TOTAL		1.02
TOTAL	6.75	1.15



BREAKEVEN POINT 1.65 E/I (2)

PROPOSED SAVINGS

PRESENT COST $ 6.75 each Ring

PROPOSED COST $ 1.15 each Ring (Tooling Amortized over 4560 details)

PROPOSED SAVINGS $ 5.60 per Dual Ring

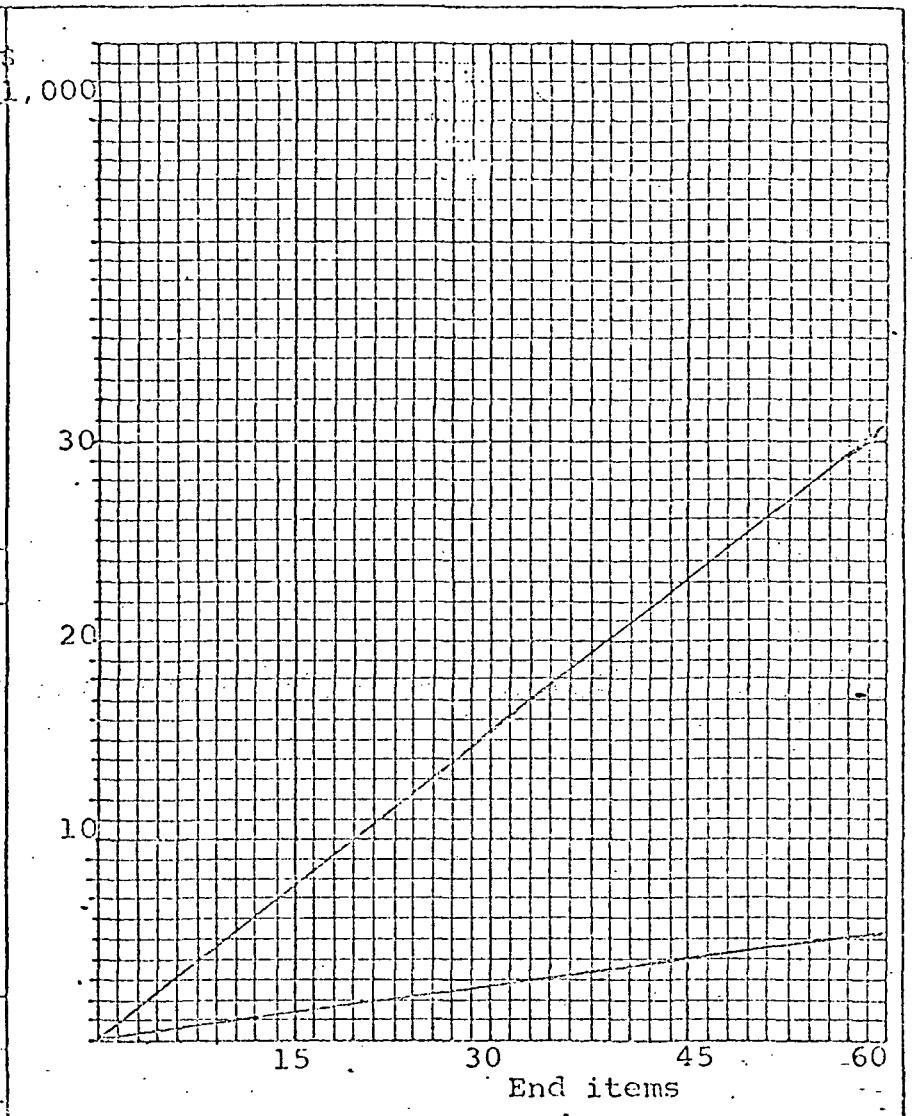
TOTAL E.I. $ 425.60

TOTAL 60 E.I. $25,536.00

COST SUMMARY

HOW MUCH WILL THAT COST?

-RECURRING	IMPLEMENTATION COST	
	PRESENT	PROPOSED
		600.00
ortized		
B-TOTAL		9.88
CURRING		
hase Part	513.00	
		77.52
B-TOTAL		77.52
TOTAL		87.40



BREAKEVEN POINT _____

PROPOSED SAVINGS

PRESENT COST $ 513 per end item

PROPOSED COST $ 87.40 per end item

PROPOSED SAVINGS $ 425.60 per end item

TOTAL 60 E/I $ 25,536.00

TRADE STUDY MATRIX **NORTHROP VENTURA**

NOMENCLATURE PRODUCIBILITY ANALYSIS REEFING RINGS	COMPARISON MATRIX OF DESIGN APPROACHES					SELECTION
FUNCTIONAL AND TECHNICAL DESIGN REQUIREMENTS	Present		Proposed			
	Dual R8127-1	Single NV STD 243-1	Investment Casting Dual	Investment Casting Single	Injection Mold Dual	
Tooling Cost	-	-	600.00	630.00	600.00	
Unit Cost	6.75	.62	.95	.48	.30	
Machining Cost, Additional	None	None	None	None	1.00	
Tooling Amortized per unit 60 E/I	-	-	.13	.07	.13	
Anodize Cost	-	-	.07	.05	-	
Total Unit Cost	6.75	.62	1.15	.60	1.43	
COST PER END ITEM	513.00	96.72	87.40	93.60	108.68	Dual less 4 singles
Savings - V.E. Preference	Present	-	$25,536.00	-	-	
Stress	o.k.	o.k.	o.k.	-	-	
Finish	63	63	63	63		
Coating	Anodize I	Anodize II			None	
Material	6061-T6	6061-T651	356-T6	356-T6	Delrin	
Delivery	-	-	Tooling 3 to 4 wks	Prod units 3 wks after 1st article	8 wks	

COATING PROCESS ANALYSIS REEFING RINGS	Alodine	Anodize	Electrolizing	Teflon	Hard Anodize	Dense Chromium	
Deposit Thickness	-	-	.00025 - .0005	.0007 - .0001	.0005 - .001	.0002 - .001	
Hardness	-	-	Rc 70 - 72		Rc 60-70	Rc 55-60	
Unit Cost Single Ring	.015	.05	.40	.20	.15	.35	
Unit Cost Dual Ring	.04	.07	.50	.25	.25	.60	
Coefficient of Friction	same as material	little better than material	-	0.05 - 0.10	-	0.13 - 0.16	
Stress				o.k.			Teflon only due to Heat
Cost per END ITEM 76 Dual, 4 Single	3.10	5.52	39.60	19.80	19.60	47.00	
Cost per 60 END ITEM	186.00	331.20	2376.00	1188.00	1176.00	2820	
Increase in cost per E/I to increase Reliability	-	Present	X	14.28	14.08	X	
Increase in cost per 60 E/I to increase Reliability	-	Present	X	856.80	844.80	X	

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 8

Part Number: R8155

Part Name: Drogue Chute

Recommended Change:

Conduct tensile tests to determine effect of uneven fullness in individual ribbons resulting from method of fabrication.

Reason:

Action:

Two action items are presented. These are as follows:

1. Manufacturing methods were investigated in order to determine method of distributing "fullness" in ribbons.
2. A rationale is presented on the "fullness" of ribbons encountered when making a FIST ribbon parachute in accordance with the "continuous ribbon" method.

Manufacturing Method:

The investigation of the manufacturing methods used in making the subject drogue parachute canopy disclosed that proper and sufficient procedures were used to assure even distribution of horizontal "fullness" within the gore structure. Templates on the gore assembly table are provided with a channel-work of small brads, which serve as a "jig" to assure alignment of all ribbons.

The upper portion of the gore is fabricated using proven methods of fabrication for gores made with overlapping horizontal ribbons. The lower two thirds of the gore is made with "continuous-horizontal" ribbons. Therefore, when laid on a "flat" pattern, with the radials converging at an angle, the horizontals have a "fullness" along the upper or trailing edge.

Figure I-A illustrates how this fullness is distributed between the radial and first adjacent vertical. The lower radial is laid first. At each horizontal ribbon crossing there is a guide mark which is perpendicular to the radial. The fabricator makes certain that each horizontal ribbon falls along this guide mark before heat tacking it to the radial. Likewise, before heat tacking the adjacent vertical, the fabricator assures that it lies in the"jig" formed by the brads so that the horizontal and vertical ribbons are perpendicular. The "fullness" in the trailing edge of the horizontal is therefore evenly distributed on both sides of the radial, between the radial ribbon and the adjacent vertical ribbon.

Figure I-B illustrates how the vertical ribbons and horizontal ribbons are assured of correct positioning before hot tacking and sewing. It is pointed out that although this jib/tack method assures proper relationship of the grid of ribbons, it cannot

assure that the finished gore grid of ribbons will not give the appearance of uneven "fullness" or "puffiness". The extent of this minimal appearance of distortion depends on the nature of the particular roll of ribbon, the "nominal tension" which the fabricator uses when she rolls the ribbon off the roll and places it in between the rows of brads, humidity, and other numerous allied fabrication and sewing factors.

Horizontal "Fullness" Rationale

Two areas of concern appear to exist in regards to the "fullness" in the continuous horizontal ribbons. The first is that of the fullness between the radial and the adjacent vertical, and the second that of the uneven "puffiness" between the horizontals and verticals in the gore grid structure. The reasons for these conditions have been described above. Their effect on the strength of the canopy is not deleterious.

Examination of photographs of inflated ribbon parachutes show that under aerodynamic pressures, both the horizontal ribbons and the vertical ribbons "balloon" out and align themselves in accordance with the air pressures being felt. Any well made FIST ribbon parachute, although showing some uneven "puffiness" or fullness in the ribbons when relaxed,

will - under inflation - demonstrate a well appearing configuration in the gore ribbon grid structure.

This is also true of the "fullness" in the trailing edge of the continuous horizontal ribbon between the radials and the adjacent verticals. In fact, as shown in Figure II, the radials and verticals tend to "fly" in an increasingly parallel position as the skirt portion is approached. Therefore, those horizontals positioned closer to the skirt "fly" in a better configuration in the suspect areas. It is of interest to note that the opposite situation exists in the case of a FIST ribbon parachute made with overlapping horizontals at the radials.

Those horizontals nearer the top of the gore will fly in a more "natural" configuration in the areas of horizontal/radial ribbon junctures; this results from the fact that during fabrication the radials and horizontals are positioned in approximately the same position assumed during the inflated state. Therefore, those horizontals closer to the skirt will be increasingly distorted in their flying position because the radials and verticals assume the parallel position previously described and shown in Figure II.

Investigation reveals that at the time of examination by the investigating team, several gores had been completed and were in the basket under the work area. The weight of the completed gores pulled on the assembly and it appeared that the ribbon did not have equal fullness on both sides of the same tape. It was demonstrated that by relieving the weight on the assembly that both ribbons had equal fullness. A change in manufacturing technique is not considered necessary.

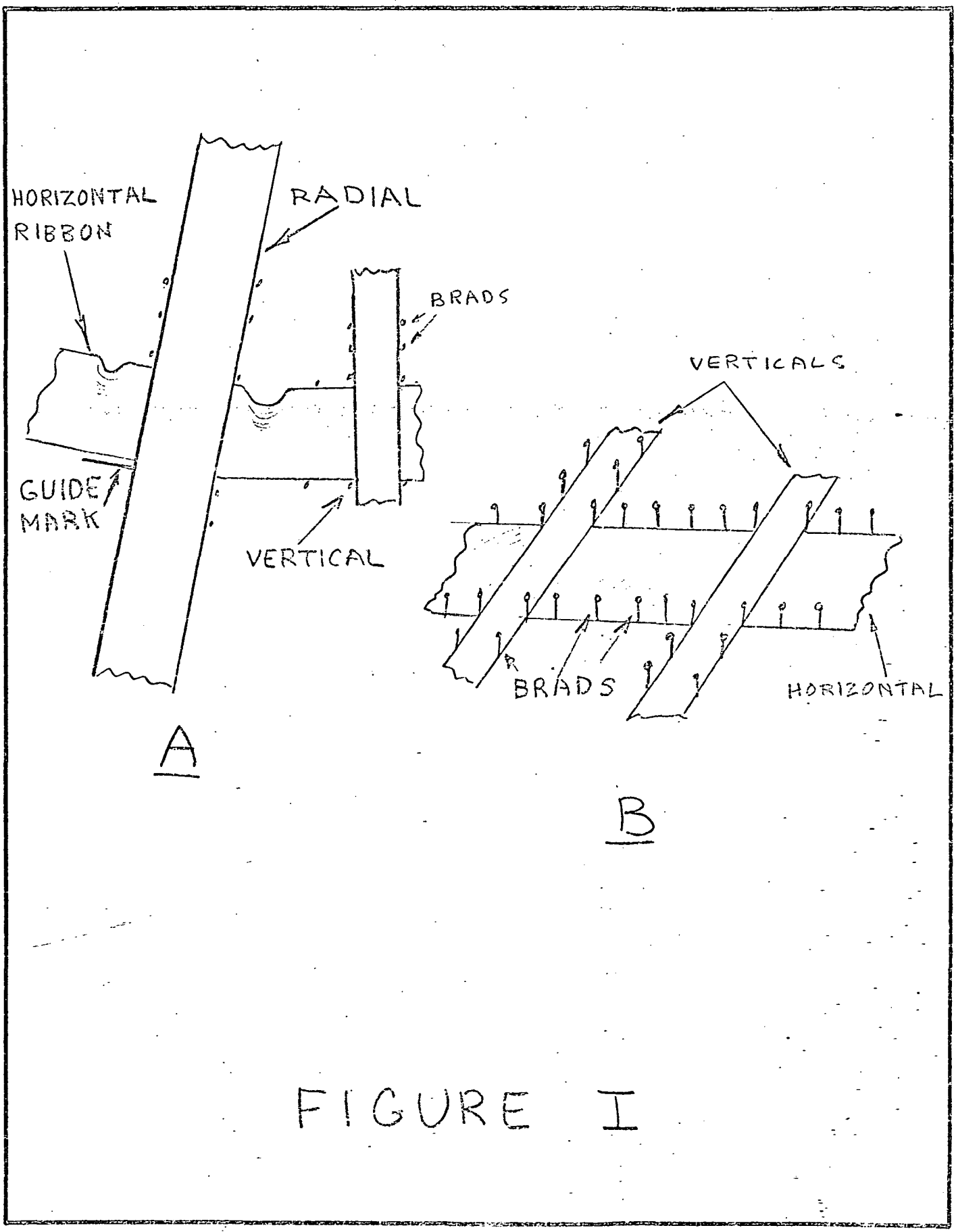

HORIZONTAL RIBBON
RADIAL
BRADS
GUIDE MARK
VERTICAL
A
VERTICALS
BRADS
HORIZONTAL
B

FIGURE I

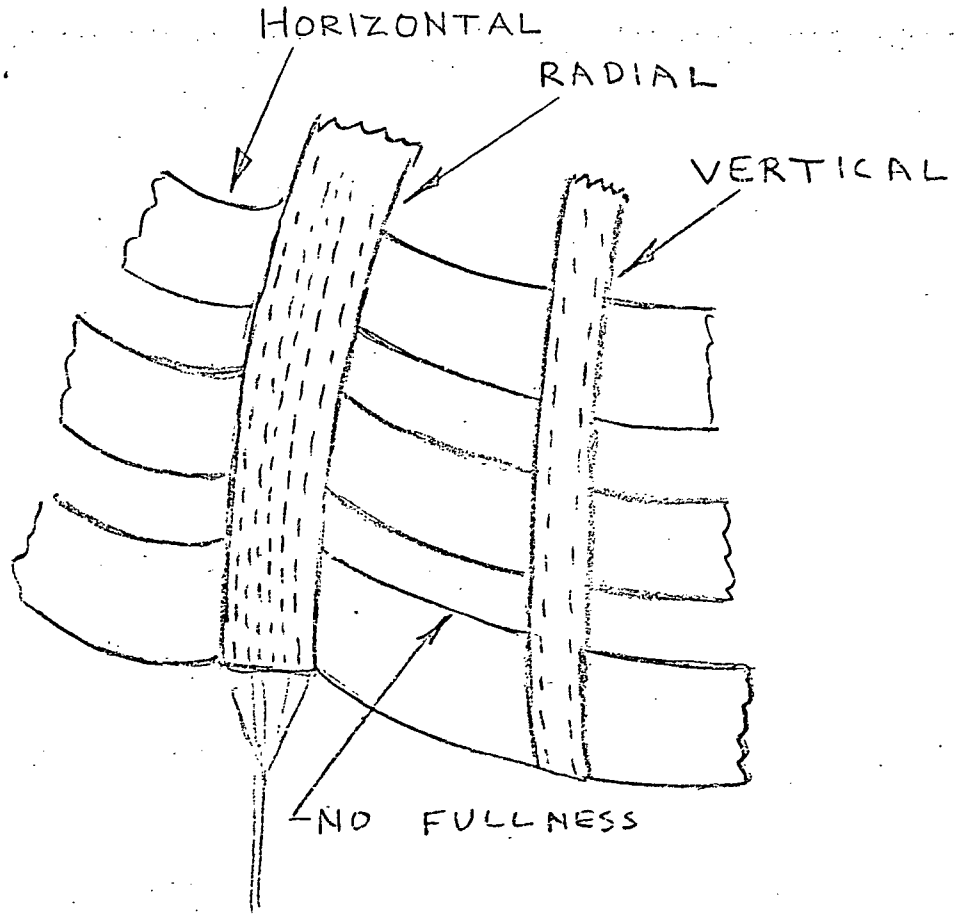


FIGURE II

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR NO. 9

Recommended Change:

Check and replace all wire nails having sharp heads (on underside) used for locating ribbons during tacking process.

Reason:

The heads could cut or fray ribbon material.

Action:

Nails were examined to determine if there were sharp edges under the headed portion which could cut or fray the ribbon material. Investigation indicates that this condition is not probable. Manufacturing will investigate the availability of spherical headed nails or brads. If they are available, existing brads will be replaced.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 10

Recommended Action and Reason:

Provide analysis defining drogue mortar muzzle velocity required to achieve bag strip-off.

Action:

The analysis requested to fulfill the requirements of this DRAR was submitted to NAR by letter NVC/67-1728/0107 dated 22 September 1967.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 11

Recommended Change:

Investigate the possibility of the drogue sabot cocking or binding in the mortar when using an erodable orifice.

Reason:

The erodable orifice is located and expels off the axial centerline of the drogue mortar assembly. The hybrid orifice is located and expels on the axial centerline of the drogue mortar assembly.

Action:

Mortar performance tests per DTP 6223-2 are scheduled to start November 11, 1967. The results of the initial tests of this series will determine which orifice will be developed. A test report will be published.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 12

Recommended Change:

Analysis of factor of safety of stainless steel riser and rationale for cooking 600°F/1 hr - investigate effect of cooking - repeatability and Q.C. requirements.

Reason:

None given.

Action:

An analysis of the factor of safety of the drogue riser steel cable will be included in the Apollo Increased Capability ELS final stress report. Development testing is in process to determine the abrasion bending - differential length degradation factor for this design and ultimate strength of the cable.

In response to the remainder of the DRAR the attached Macwhyte Company letter dated 29 November 1966 page 3 states NV introduction to the low temperature stress relieving process. The attached Macwhyte Company letter dated 18 October 1967 provides additional information on this process.

An engineering design change proposal will be submitted for further study and evaluation of this area.

1. Were 600°F samples pulled & compared to control
* 2. Have alternate lubrication methods been investigated
* 3. Have low temp pull tests been run?

*See MacWhyte Letter

Manufacturers of wire rope • wire rope slings • wire • aircraft cable • assemblies • tie rods

MACWHYTE COMPANY KENOSHA, WISCONSIN 53140

November 29, 1966

AIR MAIL!

Northrup Ventura
1515 Rancho Conejo Boulevard
Newbury Park, California

Gentlemen:

Attention: Mr. Lee Williams, Metallurgist
Materials Engineering

VARYING STRENGTH OF 7/32" 7x19 PREFORMED STAINLESS AIRCRAFT CORD AFTER MANUFACTURE INTO PILOT RISER ASSEMBLY R7672-5 AND -7

REF: LW:2630-121, 10-26-66

Our Metallurgist, Mr. Bloxdorf, has completed his tests, and I quote in part his report to me:

"I am forwarding to you all of the data which the subject company presented covering the assemblies which they make using 7/32" 7x19D PREformed Stainless Steel Aircraft Cord and the difficulties which they experience due to loss in tensile strength after subjecting the assemblies to their dry film lubrication treatment.

"They submitted a sample of their so-called Pilot Riser S/N 169 together with a sample of the 7/32" cord involved, namely, Reel No. 30680-B. Two (2) tensile tests were made upon specimens of the cord 'as fabricated', two (2) upon specimens cut from the dry film treated Pilot Riser assembly, and two (2) upon specimens from the cord 'as fabricated' after degreasing and heating at 300° F. for four hours. The results of tests are shown below as follows:

Sample Designation	B/S, Lbs.
Reel No. 30680-B	
'As fabricated' - No. 1	5560
No. 2	5560
Specimens cut from Pilot Riser	
S/N 169 - No. 1	4950
No. 2	4960

Northrup Ventura
11/29/66 - #2

Sample Designation	B/S, Lbs.
30680-B - Heated @ 300° F. for 4 hours - No. 1	4925
No. 2	4950

"Six (6) different 0.015" dia. Outer wires of the Center Strand were removed from Reel No. 30680-B. They were tested before and after heating at 300° F. for four hours. On the average, the heating was found to result in a loss in tensile strength of 3.06%.

"It is of interest to note that there is a remarkably close agreement between breaking strength of the dry film treated cord and that of the cord degreased and heated at 300° F. for four hours.

"One thing is evident, namely, when a cord is degreased and subjected to a temperature of 300° F. for four hours, it is adversely affected in strength. It is felt that this is due to an increase in frictional resistance set up between the individual strands and wires when the cord is subjected to tensile loading. It is probable that the dry film lubricant, due to the non-uniform manner in which it appears in the strands, also, sets up frictional resistance under tensile loading causing a general lowering of the actual strength."

It is evident that our tests merely serve to corroborate your experiences as summarized in your letter referenced above.

In our several phone conversations, mention has been made of a Macwhyte experimental 7/32" 7x19 Stainless Cord in which the outer wires of the Wire Strand Core (at least) wire especially processed to be less severely cold-worked with increased elongation, albeit lower strength.

We have checked our stocks and find that some of this experimental material is in our Los Angeles warehouse, namely: Tag No. G0276 (Reel No. 41000). This particular run has this specially processed "softer" wire in three different positions in the rope:

1. All the 12 outer wires of the WSC (.016" size).
2. All the 6 inner wires of the WSC (.017" size).
3. The heart wire in each of 6 outer rope strands (.017" size).

Our tests on this rope at room temperature gave us a tensile strength value of 5200 lbs.

In view of the mode of wire failures, particularly those in the wire strand core, it would seem that your investigation of this experimental 7/32" cord

is in order. If you agree, a phone call to our Los Angeles office specifying Tag No. G0276 will se t the wheels in motion.

We might mention, however, that we are not too optimistic that this experimental material when dry film lubricated and baked at 300° F. for four hours will not be adversely affected strengthwise. It seems that a 275-300° F. temperature will in itself cause a reduction in stainless steel rope strength. Information in our files indicates that at elevated temperatures there is, for stainless steel ropes, a reduction in strength as it is heated from room temperature to about 300° F. However, as the temperature is further increased, a gradual increase in stainless rope strength sets in until at about 600° F. an optimum strength is obtained.

We offer this information for what it is worth and with the realization that the most predictable behavior of stainless steel ropes is their unpredictableness.

Frankly, we believe your effort to replace the dry film lubrication technique with a special LOX compatible lubricant applied at room temperature is the best answer to your problem, your customer willing.

We might also throw in for discussion the fact that in any Apollo project the characteristics of stainless steel rope at sub-zero temperatures be considered - that any tests performed at room temperature may in truth be somewhat less than meaningful.

In any event, we are happy to have had this opportunity to discuss this problem with you and can only hope that our efforts will in some degree help you to resolve the same.

Yours very truly,

MACWHYTE COMPANY

F. Chiappetta

F. Chiappetta
Chief Product Engineer

FC AS

Manufacturers of wire rope • wire rope slings • wire • aircraft cable • assemblies • tie rods

MACWHYTE COMPANY · KENOSHA, WISCONSIN 53140

October 18, 1967

Northrop Ventura
1515 Rancho Conejo Boulevard
Newbury Park, California

Gentlemen:

Attention: Mr. Lee Williams, Lead Engineer
Materials Engineering

STRENGTH VARIATION PHENOMENON IN STAINLESS AIRCRAFT QUALITY, 7x19 CONSTRUCTION CABLE
REFERENCE: LW:2630-293
NORTHROP VENTURA LETTER OF 9-18-67 TO INTERNATIONAL NICKEL COMPANY

With respect to the questions raised in the above referenced letter, we would offer the following answers and/or opinions:

1. We believe there are some peculiarities in rope fabrication that seem to indicate a temporary metastable condition, but we do not believe that stainless cable per MIL-C-5424 is per se, metastable! It has been our general experience that with time a sort of mechanical stress-relieve takes place and any cable strength loss is compensated for by increased wire elongations, greater cable fatigue resistance and a general cable improvement.

2. The hardening mechanism in the 600°F/1 hour bake is a stress relieving operation which serves to re-orient the wire grain structure to give higher yield strengths and self-equalization tendencies to the cable.

3. This upgrading by stress relieving is stable.

4. A higher strength cable can be produced by stress relieving at any time after manufacture -- by baking at 600°F. or mechanically by a moderate "swage" or use of heavy roller pressure.

Northrop Ventura
10-18-67 #2

Although it is not necessary to stress relieve the rope within any prescribed time limit, we believea thirty day lag (contrary to no lag) between wire drawing and rope fabrication will make for a superior rope.

The above represents more or less a consensus gleaned from various sources including our own and is submitted for what it is worth.

We certainly would appreciate being advised as to the answers received from International Nickel and Battelle and also as to your own final conclusions.

Not having heard from you relative to the problem with 1/4" 7x19 Stainless Cable, we assume that the degrease and dry film application at 600° F. has resolved the dilemma and has removed the curse of any current urgent action.

Yours very truly,

MACWHYTE COMPANY

F. Chiappetta

F. Chiappetta
Chief Product Engineer

FC CT

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 13

Part Number: R8155

Part Name: Drogue Riser Assembly

Recommended Change:

Change the attachment sewing of riser line where steel cable is attached plus add a keeper.

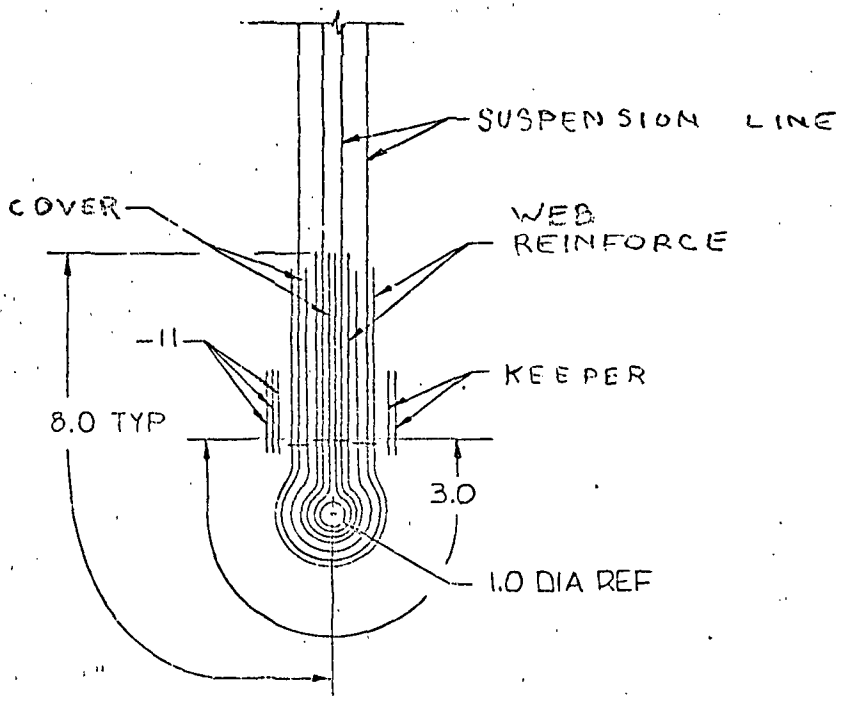
Reason:

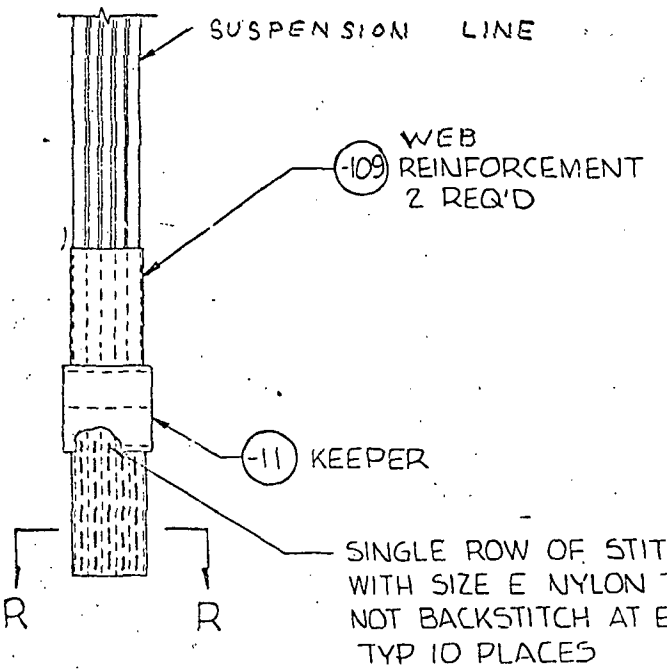
Action:

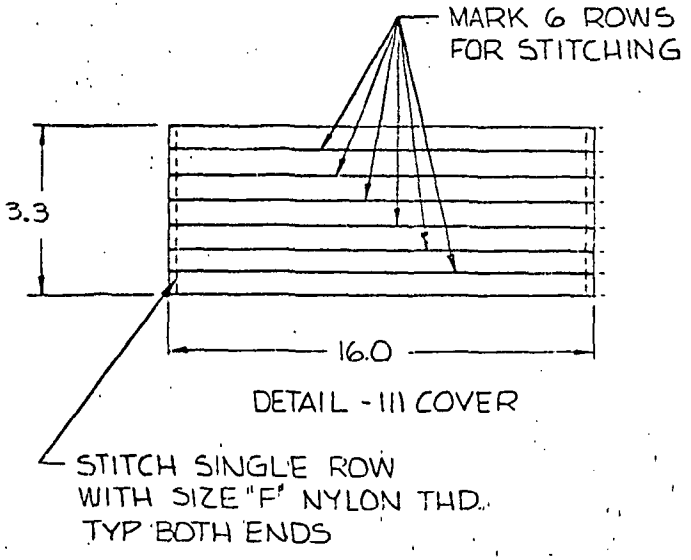
The terminal end of the riser, which is formed as an integral portion of the suspension line/riser assembly by suspension line loops, is now supported and positioned by a webbing/cloth tunnel arrangement. A minimum of sewing, three inches, is used per line at this end. This is straight sewing, not zig/zag A figure is attached to show details of this new terminal end. Note that a keeper is employed, as was on the original design.

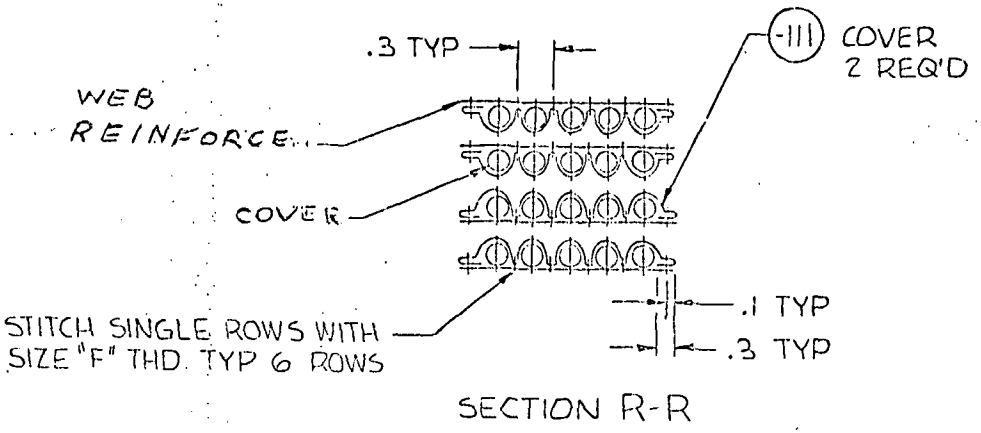
Drawing R8155 ADCN B6 and B8.

DRAR # 12









DROGUE RISER END

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 14

Part Number: R8058

Part Name: Pack Assembly, Main

Recommended Change:

Properly color code all three main chute reefing lines, cutters, and cutter pockets.

Reason:

To prevent mix-up in packing operations.

Action:

A system of three colors has been provided in the reefing system. The first stage reefing lines will be Olive Drab and Yellow in color. The second stage reefing line will be Natural.

The presently used reefing cutter pocket will be used at those positions where the first stage O.D. line is routed through the cutter. At the present time, two means of coloring this pocket are being explored. The first involves the use of colored parachute marking ink which will be applied to the present pocket. Specification white and yellow ink will be used. The second means of coloring involves the use of a colored cloth to replace the present O.D. "cover" portion of the pocket assembly.

First stage reefing cutters are to be finished in a dark brown/ black finishing. This will distinguish them from the seond stage cutters, which are to be supplied in a natural, stainless steel finish.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 15

Part Number: R8155

Part Name: Drogue Parachute Assembly

Recommended Change:

Justify by study changing drogue suspension/riser line from nylon to dacron.

Reason:

Weight and volume savings.

Action:

The data which follows forms the basis for NV's choice of dacron lines.

Flight stability (aero-elastic) of the drogue parachute assembly was an important primary consideration in choosing lines made of dacron. Desirable aero-elastic stability behavior may be expected when using dacron lines (which has lower elongation characteristics) instead of nylon lines. Test experience to date has indicated that coreless braided dacron sometimes exhibits random low breaking values. Therefore, the use of 2000 lb nylon line has been considered.

Tests made by the NV Material Laboratory indicate that the stress/strain characteristics of such nylon lines are comparable to the 1550 lb dacron line. Attached is Figure 3 of MLTR No. 5401, which compares the stress/strain characteristics of 2000 lb nylon cord and 1550 lb dacron cord.

One of the important primary consideration in choosing nylon lines was that of flight stability (aero-elastic) of the parachute assembly. A more desirable aero-elastic stability behavior can be expected when using lower elongation dacron lines instead of nylon.

This action item, however, deals only specifically with weight data. Figure 1 illustrates details of the three (3) configurations studied. Table A gives the weight analysis. This table demonstates that the use of NV developed dacron coreless line imposes little weight penalty over an all nylon cord suspension line/riser system; it also demonstrates that the use of NV developed dacron line has a decided weight advantage over a nylon suspension line/dacron webbing riser combination configuration.

Configuration "A", see Figure 1, considers a suspension line/riser as an integral unit, with nylon cord being used. It should be noted that this configuration was included for academic

interest only, as the use of an all-nylon system would be prohibitive due to the extremely undesirable flight characteristics associated with aero-elastic stability problems.

Configuration "B" considers the suspension lines being made of nylon coreless line, and the riser section being made of dacron webbing. This type of configuration is used on the present Apollo Block II drogue parachute canopy.

Configuration "C" considers a suspension line/riser as an integral unit, with specially developed NV high strength dacron coreless braided line. This configuration is the one employed on the I.C. Block II drogue parachute canopy, R8155.

The weight data compiled is based on a L/M involving only the material used in the suspension line and riser system.

In order to make the comparison as accurate and meaningful as possible, the weight/length factor for the nylon coreless braided line was evolved by a study of available high strength nylon lines made in accordance with NV MPDS specifications. That is, there is not presently available a 1500 lb. high strength NV MPDS suspension line. Therefore, the weight factor of .027 lbs/yd was obtained by a study of other nylon coreless braided lines already developed by NV. It is pointed out that if the standard 1500 lb., MIL-C-7515, line were used in this analysis, the

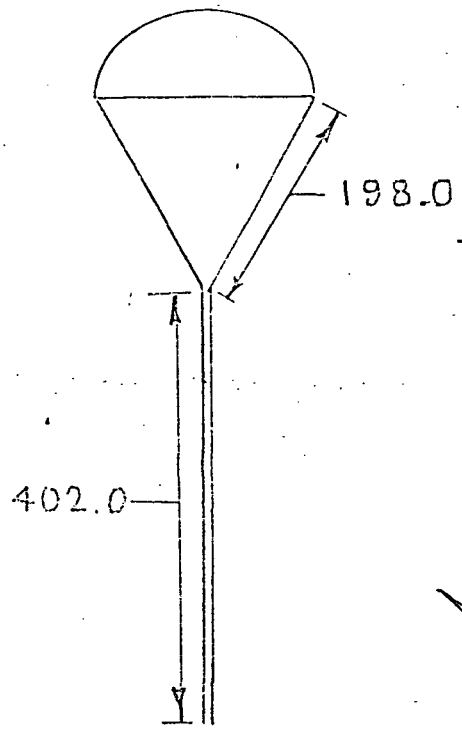
configuration "A" system would be heavier than the all dacron coreless line system based on an expected weight factor of .036 lbs/yd.

The weight factor of .02777 lbs/yd for the 1550 lb. dacron coreless braided line is based on actual weight values obtained at the NV Material Laboratory. The NV specification number for this cord is MPDS 5-25.601, Type II.

The weight factor of .060696 lbs/yd for the 3,100 lb. dacron webbing is also based on actual weight values. The NV specification number for this webbing is MPDS 5-25.404, Type IX.

Table A compiles the weight data. It shows that the all dacron, coreless braided line configuration is 0.5 pounds lighter than the use of the nylon suspension line, dacron webbing riser combination.

Attached:
Figure 1
Table A



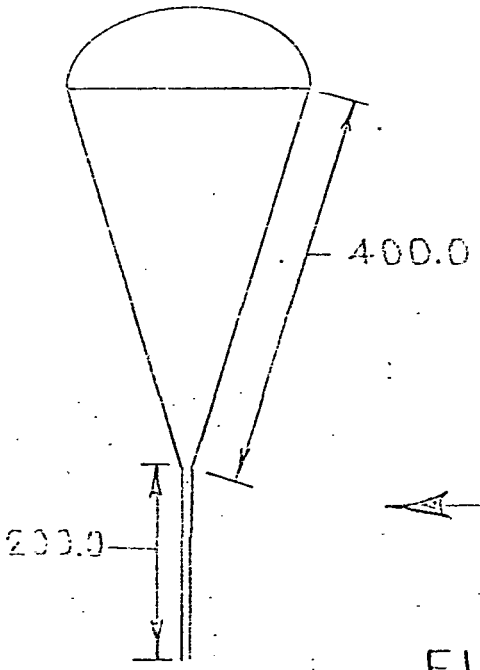
CONFIGURATION "A"

INTEGRAL SUSPENSION LINE / RISER MADE OF NYLON CORELESS LINE.

CONFIGURATION "B"

SUSPENSION LINE MADE OF NYLON CORELESS LINE.

RISER MADE OF DACRON WEBBING.



CONFIGURATION "C"

INTEGRAL SUSPENSION LINE/ RISER MADE OF DACRON CORELESS LINE.

FIGURE I.

ENGINEERING LOG BOOK

FORM 30-345 (11-65) NORTHROP VENTURA

DATE _____

PAGE _____ OF 1

SUBJECT DRAR #15 PERFORMED BY _____ ORGN. _____

SIGNATURE

PROJECT I.C. APOLLO EWR NO. _____

TABLE A

		1	2	3	4	5	6	7	8 (6+7)	9
CONFIGURATION										TOTAL WT - LBS
YARDAGE - SUSPENSION LINE										WEIGHT-LBS- RISER
MATL - DACRON - .0277 LBS/YD										WEIGHT-LBS - LINES
LINE - MPDS ***** - .02777 LBS/YD										YARDAGE - RISER PORTION
MATL - NYLON CORELESS										MPDS ***** - C50696 LBS/YD
LINE MPDS ***** - .027 LBS/YD										MATL - DACRON WEBBING - 3100 #
MATL - DACRON WEBBING - 3100 #										LINE MPDS ***** - C50696 LBS/YD
YARDAGE - RISER PORTION										MATL - NYLON CORELESS
WEIGHT-LBS - LINES										LINE - MPDS ***** - .02777 LBS/YD
WEIGHT-LBS- RISER										MATL - DACRON - .027 LBS/YD
TOTAL WT - LBS										YARDAGE - SUSPENSION LINE
		1	2	3	4	5	6	7	8 (6+7)	9
A		1155		.027		2288	3.12	6.18	9.30	
B		1155		.027	.0606696	114.4	3.12	6.94	10.06	
C		2277	.02777			116.6	6.32	3.24	9.56	

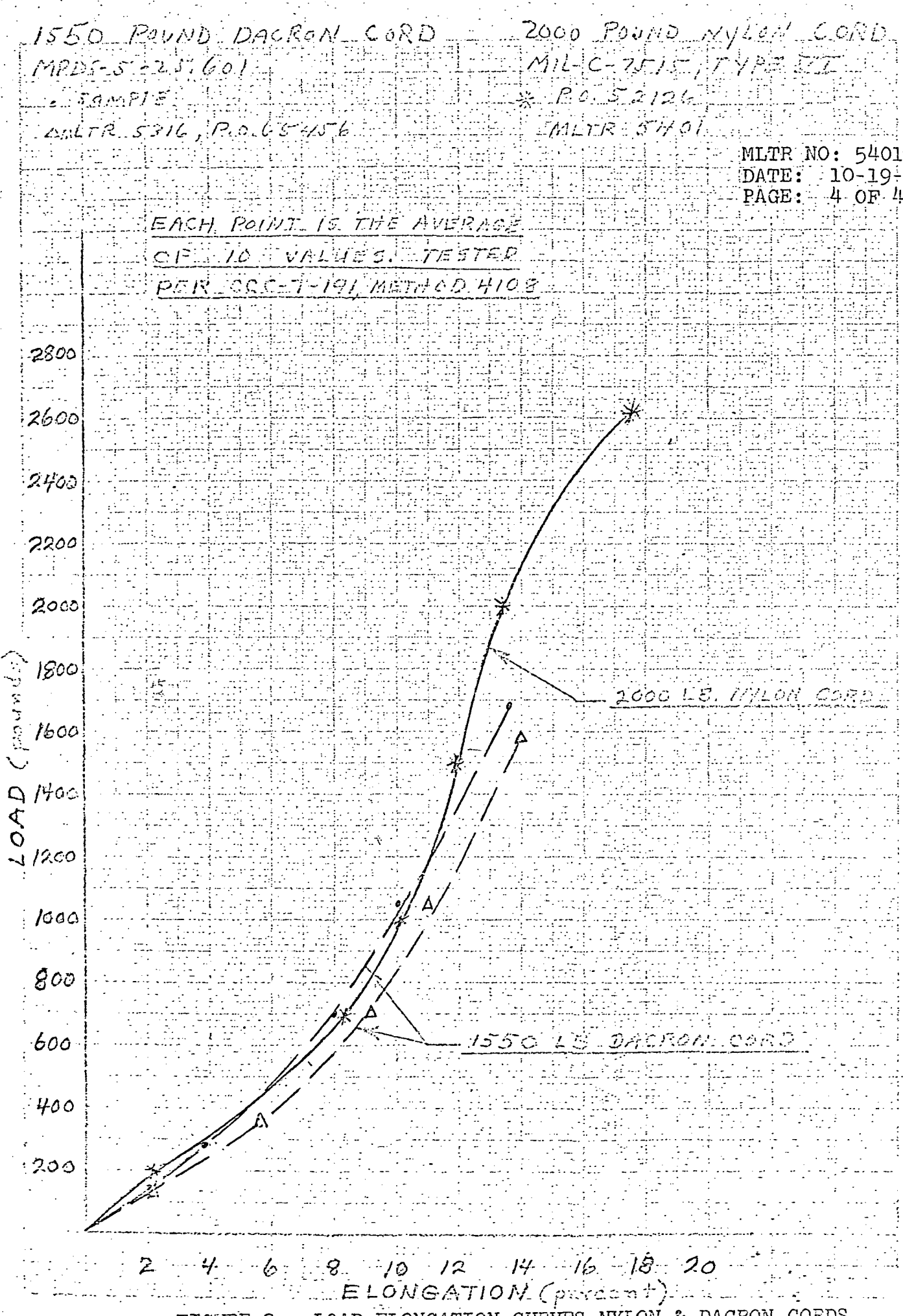


FIGURE 3: LOAD-ELONGATION CURVES-NYLON & DACRON CORDS

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 16

Recommended Change:

Conduct a comparative cost analysis of coating the dual reefing rings with teflon versus the present method of an anodize surface.

Reason:

The teflon coat will reduce possible reefing line hang up and burning.

Action:

The value analysis summary and recommendations are included in DRAR No. 7.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 17

Recommended Change:

Conduct an analysis of reefing line loads.

Reason:

To define reefing line strength margins.

Action:

Reefing Line Loads in the 83.5-ft D_o Ringsail

Analysis of measured reefing line loads reveals that the maximum tension in the reefing line is not related to the peak longitudinal load of the parachute. The maximum tends to occur later in the reefed interval while the parachute load is dropping toward its terminal value. In some cases the maximum reefing line tension occurred at disreef.

The ratio of instantaneous reefing line to canopy forces is found to be proportional to measured canopy development angles but less than is indicated by theory, where the development angle is defined as the angle between a suspension line and the canopy radial at the skirt.

Summary:

A formal report of the reefing line load investigation is being prepared (NVR 6100). Following is a summary of the conclusions and recommendations.

1. Maximum measured reefing line loads show a rough correlation with the average canopy load over the reefed interval.

2. The ratio of instantaneous reefing line to canopy loads reached a maximum at the end of the reefed interval when the canopy development angle was a maximum and the system was approaching a near-equilibrium condition.

3. Related to the weight fraction supported by one canopy, the measured reefing line loads did not exceed:

   2.5% (W/n_c) during Stage I

   4.0% (W/n_c) during Stage II

   (n_c = number of canopies in test)

4. Since friction could have prevented the load transducers from feeling true maxima, the recommended design limit loads indicated by theory are in round numbers:

   3% KW for Stage I

   5% KW for Stage II

   Where: K = system weight fraction applied to one canopy in the worst design case.

5. For the present design basis KW is approximately 10,000 lbs and:

   T_{R_1} (des. lim.) = 300 lbs for Stage I

   T_{R_2} (des. lim.) - 500 lbs for Stage II.

6. The margin of safety of the first stage reefing line was found to be 1.14 while the second stage line has a margin of safety of 0.39. The second stage line carries a low snag degradation factor as well as factors of abrasion, splice and thermal degradation. See attached report.

   Drawings:

   R8102 First Stage Reefing Line

   R8125 Second Stage Reefing Line

FORM 30-381 (N. 12.66)

W. HUYLER PREPARED	NORTHROP VENTURA	PAGE NO. 1 OF 2
CHECKED	FIRST STAGE REEF. LINE	REPORT NO.
DATE		MODEL NO.

R8102-1 REEFING LINE

REF:

MATERIAL: REF.

CORELESS BRAIDED NYLON LINE, MIL-C-7515
1000 lb. B.S., TYPE IV.

DESIGN LOADS: REF.

300 x 1.35 = 405 lbs. ULT

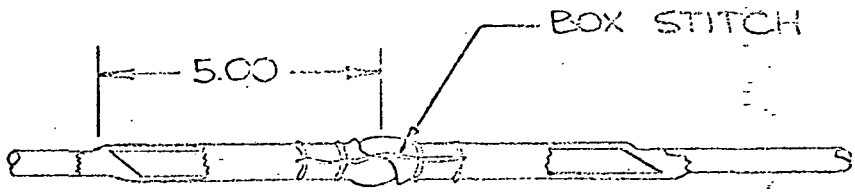
ENVIRONMENT: REF.

101°F AT FULL OPEN

DESIGN FACTORS: REF.

ABRASION	.96
SPLICE	.97
THERMAL	.93

GEOMETRY:



SPLICE ["CHINESE FINGER"]

W. HUYLER PREPARED	NORTHROP VENTURA	PAGE NO. 2 OF 2
CHECKED	FIRST STAGE RECIP. LINE	REPORT NO.
DATE		MODEL NO.

STRENGTH ANALYSIS:

THE CRITICAL POINT IS AT THE SPLICE.

FOR THE REDUNDANT SYSTEM IT CAN BE SHOWN A SINGLE LINE CAN CARRY THE LOAD, THEREFORE

$$M.S._{TENSION} = \frac{1000(0.96)(0.97)\,0.93}{905} - 1 = \frac{1.14}{ULT.}$$

FORM 30.381 (N. 12.66)

W. HUYLER PREPARED	NORTHROP VENTURA	PAGE NO. 1 OF 2.
CHECKED	SECOND STAGE REEFING LINE	REPORT NO.
DATE		MODEL NO.

R 9125 -1 REEFING LINE

REF.

MATERIAL:

CORELESS BRAIDED NYLON LINE, MIL-C-7515
1500 lb. B.S., TYPE IV

F_{TU} = 1500 lb REF.

DESIGN LOADS: REF.

500 x 1.35 = 675 lbs. ULT.

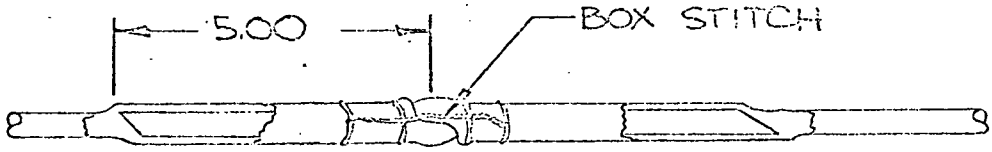
ENVIRONMENT: REF.

101 °F AT FULL OPEN

DESIGN FACTORS:

ABRASION	.96	REF.
SNAG	.72	REF.
SPLICE	.97	REF.
THERMAL	.93	REF.

GEOMETRY:



SPLICE ["CHINESE FINGER"]

FORM 30-381 (N. 12-65)

W. HUYLER PREPARED	NORTHROP VENTURA	PAGE NO. 2 OF 2
CHECKED	SECOND STAGE REEFING LINE	REPORT NO.
DATE		MODEL NO.

STRENGTH ANALYSIS:

THE CRITICAL POINT IS AT THE SPLICE.

$$M.S._{TENSION} = \frac{1500(0.96)\,0.72\,(0.97)\,0.93}{675} - 1 = \frac{0.39}{ULT.}$$

FORM 30-381 (N. 12-66)

W.C. HUYLER PREPARED	NORTHROP VENTURA	PAGE NO. 1 OF 2
CHECKED	SNAG DEGRADATION FACTOR	REPORT NO.
DATE		MODEL NO.

REF: TER 1616 D6237-1

THE NEED FOR A SNAG DEGRADATION FACTOR WAS MADE EVIDENT BY THE DYNAMIC DISREEF TEST OF THE APOLLO MAIN PARACHUTE DUAL REEFING SYSTEM. A NUMBER OF SNAGS OR LOOPS APPEARED IN THE SECOND STAGE REEFING LINE AFTER THE DRAWSTRING HAD BEEN CUT. THE PRESENCE OF THESE SNAGS LOWERED THE ULTIMATE STRENGTH OF THE REEF LINE CONSIDERABLY.

THE RESULTS OF THE TESTING IS LISTED IN TABLE I.

THE LOWEST BREAKING STRENGTH OF THE SNAGGED SPECIMENS WAS 1760 lb. THE AVERAGE CONTROL SAMPLE STRENGTH WAS 2442 lb.

$$\therefore \text{FACTOR} = \frac{1760}{2442} = \underline{.72}$$

PREPARED	NORTHROP VENTURA	PAGE NO. 2 OF 2.
CHECKED	SNAG DEGRADATION FACTOR	REPORT NO.
DATE		MODEL NO.

TABLE I

CONTROL SAMPLE ULT. BREAKING STRENGTH

(1.)	2570 lb.	2442 lb Avg.
(2.)	2450 lb.	
(3.)	2330. lb.	
(4.)	2420 lb.	

SNAGGED SPECIMEN ULT. BREAKING STRENGTH

(1)	1915 lb.
(2.)	2240 lb.
(3.)	2290 lb.
(4.)	1970 lb.
(5.)	1760 lb.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 18

Part Number: R8155

Part Name: Drogue Riser Sleeve

Recommended Change:

Provide method of securing ends of riser sleeve to prevent them from coming free during deployment.

Reason:

Method described appears to be same as used on 80-series pilot riser. Sleeve came loose at one end and bunched up on riser.

Action:

A "stirrup" loop has been incorporated into the lower end of the sleeve as shown on the attached figure. This loop is routed between clevis and the end loop of the riser, thus providing anchorage for the lower end of the sleeve. The upper end of the sleeve is now secured to the riser keeper with 10 tacks of "E" thread; previously, this was accomplished with four (4) tacks.

Drawing R8155 ADCN B-5.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 19

Recommended Change and Reason:

NV to provide study defining allowable reefing cutter tolerances relative to parachute loads.

Action:

The study requested by this DRAR was partially fulfilled by a submittal to NAR by letter NVC/67-1747/0107 dated 5 October 1967. A correlation analysis of reefing cutter delay time variability versus parachute loads is still in process and will be submitted upon completion.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 20

Recommended Change:

Conduct analysis of main parachute loads in the event of a second stage reefing line failure.

Reason:

The determination of main parachute loads and safety factors is a design requirement.

Action:

Failure of a second stage reefing line could permit the parachute with the failed reefing line to inflate to full open at the end of the first reefing stage. The load in the parachute when operating in either a two or three cluster system for the critical high altitude abort, one drogue case was calculated.

The second stage reefing line was assumed to fail at the end of the first stage or at the start of the second stage. Failure of the reefing line at some time during the second stage would be less critical because the dynamic pressure at this time would be less than that assumed. The load in the parachute with the failure reefing line was calculated using the shock factor method, along with drag area and shock factor values that were developed during Block I. The method is valid for this calculation since disreef of the parachute with the failed reefing

line develops from a first stage drag area that is about the same as that used for the Block I system, i.e., 353 square feet for Block I and 300 square feet for present system.

Summary:

The following presents the results of the analysis for the critical high altitude abort case:

Condition	Load in Chute with Failed Reefing Line (lb)	Total Load (lb)
1D-2M	44,700	50,250
1D-3M	29,400	39,000

For one drogue entry conditions, the dynamic pressure at the end of first stage disreef is about the same as was used for the high altitude abort cases considered. Therefore, the loads would also be the same within the accuracy of the calculation.

The minimum factors of safety of the drogue riser and main canopy for the one drogue-two main chute condition are all less than 1.0 and between 1.0 and 1.25 for the one drogue-three main chute condition.

Summary
Minimum Factors of Safety

Part No.	Title	Factor of Safety Con 1D2M	Con 1D3M
R8061	Riser	.82	1.09
R7661	Canopy		
	-99 suspension line	.75	1.00
	-59 and -61 radial tape	.94	1.25
	Sail #6	.89	1.19
	Sail #7	.89	1.19
	Sail #8	.80	1.06
	Sail #10	178	1.04

Drawings:

R7541	Main Parachute Assembly
R7661	Parachute Ringsail 83.5' D_o conical
R8061	Riser Assembly

FORM 30-381A (N. 12-66)

PREPARED	NORTHROP VENTURA	PAGE NO. OF
CHECKED		REPORT NO.
DATE		MODEL NO.

PRELIMINARY STRENGTH ANALYSIS APOLLO ELS MAIN PARACHUTE WITH MISSED SECOND STAGE REEFING

PREPARED BY:

W. MULLINS

APPROVED BY:

R A. Domick

FORM 30-381A (N. 12-66)

W. MULLINS PREPARED	NORTHROP VENTURA	i PAGE NO. OF
CHECKED		REPORT NO.
DATE 4 OCT 67		MODEL NO.

ABSTRACT

THIS ANALYSIS INCLUDES CALCULATIONS OF SAFETY FACTORS FOR THE APOLLO MAIN PARACHUTE FOR TWO SPECIAL LOAD CONDITIONS NOT PREVIOUSLY COVERED. FACTORS LESS THAN 1.0 OCCUR IN SOME AREAS.

USE IS MADE OF DATA ON MATERIAL PROPERTIES AND JOINT EFFICIENCIES PREVIOUSLY PRESENTED IN REF 1.* A NEW METHOD OF ANALYSIS IS USED TO DETERMINE CANOPY INTERNAL LOAD DISTRIBUTION. (APPENDIX A)

REF 1 : NVR 4055, STRENGTH ANALYSIS OF APOLLO EARTH LANDING SYSTEM

FORM 30-381A (N. 12-66)

W. MULLINS PREPARED	NORTHROP VENTURA	1 PAGE NO. OF
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DATE 10/4/67		MODEL NO.

SUMMARY

MINIMUM FACTORS OF SAFETY

PART NO.	TITLE	FACTORS OF SAFETY COND 10 2M.	COND 1D 3M.	PG.
R8061-1	RISER	.82	1.09	4
R7661	CANOPY			
	-99 SUSPENSION LINE	.75	1.00	5
	-5961 RADIAL TAPE	.94	1.25	5
	SAIL #6	.89	1.19	8
	SAIL #7	.89	1.19	8
	SAIL #8	.80	1.06	8
	SAIL #10	.78	1.04	8

W. MULLINS PREPARED	NORTHROP VENTURA	2 PAGE NO. OF
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DESIGN LOADS

CONDITION	LOAD LB	THERMAL DEGRADATION FACTOR
ID 3M (HIGH ALT. ABORT)	32,000	0.95 *
ID 2M (HIGH ALT ABORT	42,400	0.95

REF 1 PG D3 100°F

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FACTORS OF SAFETY

RESULTS OF THIS ANALYSIS ARE PRESENTED IN TERMS OF FACTORS OF SAFETY FOR THE DESIGN CONDITIONS. CANOPY LOADS ARE COMPUTED IN APPENDIX A FOR A LOAD OF 41,200 LB. ALTHOUGH THE RELATIONSHIP ON INTERNAL TO EXTERNAL LOADS IS NOT EXACTLY LINEAR, A CLOSE APPROXIMATION OF FACTORS OF SAFETY FOR OTHER LOAD VALUES IS OBTAINED AS FOLLOWS:

$$FS = \frac{41200 \times \text{THERMAL FACTOR} \times FS \text{ AT } 41200 \text{ LB}}{\text{DESIGN LOAD}}$$

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R 3061-1 RISER

FROM REF 1, THE DIVERGENT STRAPS ARE THE CRITICAL COMPONENTS OF THIS ASSEMBLY, WITH AN ALLOWABLE LOAD OF 7008 LB EACH.

COND 10 3M $FS = \frac{7008\,(.95)(.97)(.95)^{*}}{12/68\,(32000)} = 1.09$

COND 10 2M $FS = \frac{7008(.95)(.97)(.95)^{*}}{12/68\ 42700} = .82$

*UNSYMMETRIC, CONVERGENCE, AND THERMAL FACTORS

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-99 SUSPENSION LINES

FROM REF 1

STITCHING EFF = .86 *

UNSYMETRIC FACTOR .95

ABRASION FACTOR = .96

THERMAL FACTOR = .95

FROM APPENDIX A

CONVERGENCE FACTOR = .97 (SINϕ AT SKIRT)

RATED LOAD ~ 650 LB

COND ID 3M

$$FS = \frac{650(.86)(.95)(.96)(.97)(.95)}{1/68\ (32000)} = 1.0$$

COND 1D 2M

$$FS = \frac{650(.86)(.95)(.96)(.97)(.95)}{1/68\ (42,400)} = .75$$

* REF: NV MATERIALS LABORATORY TEST REPORT TEXTILES, NO. 5298 DATED 8/18/67

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RADIAL TAPES

MAXIMUM LOAD IN THE RADIAL TAPES IS 624 LB (PG A-9)

ALLOWABLE LOAD

350 LB NYLON TAPE ~ MPDS 5-25.394 TYPE III

UNSYMETRICAL LOADING FACTOR = 0.95
ABRASION FACTOR = 0.96

FOR 2 TAPES

ALLOWABLE LOAD = $2(350)(0.95)(0.96) = 638$ LB

FOR 41200 LB LOAD

$$FS = \frac{638}{624} = 1.02$$

COND 1D 3M $\quad FS = \frac{41200}{32000}(1.02)(.95)^{*} = 1.25$

COND 1D 2M $\quad FS = \frac{41200}{42400}(1.02)(.95)^{*} = .94$

* THERMAL FACTOR

FORM 30-381A (N. 12-66)

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SAILS

ALLOWABLE HOOP LOADS FOR SAIL MATERIAL IS GIVEN IN APPENDIX D-4 OF REF 1 AS 55.3 % OF MATERIAL RATED STRENGTH. THIS VALUE INCLUDES THE EFFICIENCY OF RADIAL SEAMS ALONG EACH EDGE OF THE SAILS. IN THE ELASTIC MODEL IN THE ANALYSIS OF APPENDIX A, STIFFNESS OF REINFORCING TAPES IS DISTRIBUTED OVER ADJACENT SAIL AREA (SEE PG A4 & A6). IN DETERMINING ALLOWABLE LOADS, TAPE MATERIAL IS DISTRIBUTED IN THE SAME MANNER.

FORM 30-381A (N. 12-66)

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SAILS (CONTD)

SAIL NO.	STA *	ALLOWABLE LOAD	LOAD *	FS 41200	FS 10 2M	FS 10 3M	
1	15	45	29	1.6			
2	14	45	29	1.6			
3	13	45	29	1.6			
4	12	49	29	1.7			
5	10	102	36	2.8			
6 TE	9AT	29	30	.97	.89	1.19	3C
6	9	27	18	1.5			
6 LE	8AL	24	10	2.4			
7 TE	8AT	30	31	.97	.89	1.19	21
7	8	27	17	1.6			
7 LE	7AL	24	8	3			
8 TE	7AT	26	30	.87	.80	1.06	13
8	7	27	17	1.6			
8 LE	6AL	23	7	3.3			
9TE	6	107	59	1.8			
9	5	19	9	2.1			
9 LE	4AL	12	5	2.4			
10 TE	4AT	23	27	.85	.78	1.04	21
10	4	21	10	2.1			
10 LE	3AL	18	4	4.5			
11 TE	3AL	19	9	2.1			
11	3	19	6	3.2			
11 LE	2AL	19	3	6.3			
12 TE	2AT	19	6	3.2			
12	2	19	4	4.8			
12 LE	1	1033	3	HIGH			

* FROM APPENDIX A

** ALLOWABLE LOAD = $\frac{\text{RATED STRENGTH}}{1 + \text{RADIAL ELONGATION}}$ X SEAM FACTOR [.553]

FORM 30-381A (N. 12-66)

W. MULLINS PREPARED	NORTHROP VENTURA	A1 PAGE NO. OF
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APPENDIX A

CANOPY LOAD ANALYSIS

FORM 30-381A (N. 12-66)

W. MULLINS PREPARED	NORTHROP VENTURA	A2 PAGE NO. OF
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DATE 10/4/67		MODEL NO.

LIST OF SYMBOLS

R_1	RADIUS OF CURVATURE, MERIDIONAL ~ IN.
V_i	TOTAL VERTICAL LOAD IN CANOPY ABOVE STATION i ~ LB
p	DIFFERENTIAL PRESSURE ~ PSI
N_θ	CIRCUMFERENTIAL COMPONENT OF SAIL LOAD ~ LB/IN.
r	LOCAL RADIUS IN HORIZONTAL PLANE ~ IN.
Φ	ANGLE BETWEEN PERPENDICULAR TO CANOPY SURFACE AND CENTRAL AXIS ~ °
P_R	LOAD IN RADIAL TAPE ~ LB
$\Delta S'$	MANUFACTURED LENGTH OF RADIAL TAPE BETWEEN REFERENCE STATIONS ~ IN.
ϵ_R	ELONGATION OF RADIAL TAPE ~ IN/IN.
$\Delta\Phi$	CHANGE IN ANGLE Φ BETWEEN STATIONS ~ °
ψ	HALF INCLUDED ANGLE OF BULGE °
N_ψ	UNIT TENSILE LOAD IN BULGE ~ LB/IN.
ϵ_s	ELONGATION OF SAIL ~ IN/IN.
A	TOTAL PROJECTED AREA AT STATION ~ $IN.^2$
M	NUMBER OF GORES
α	GORE HALF ANGLE, PROJECTED ~ °
S_M	MANUFACTURED WIDTH OF SAIL ~ IN.
BS	RATED STRENGTH OF SAIL ~ LB/IN

FORM 30-381 (N. 12-66)

W. MULLINS PREPARED	NORTHROP VENTURA	A3 PAGE NO. OF
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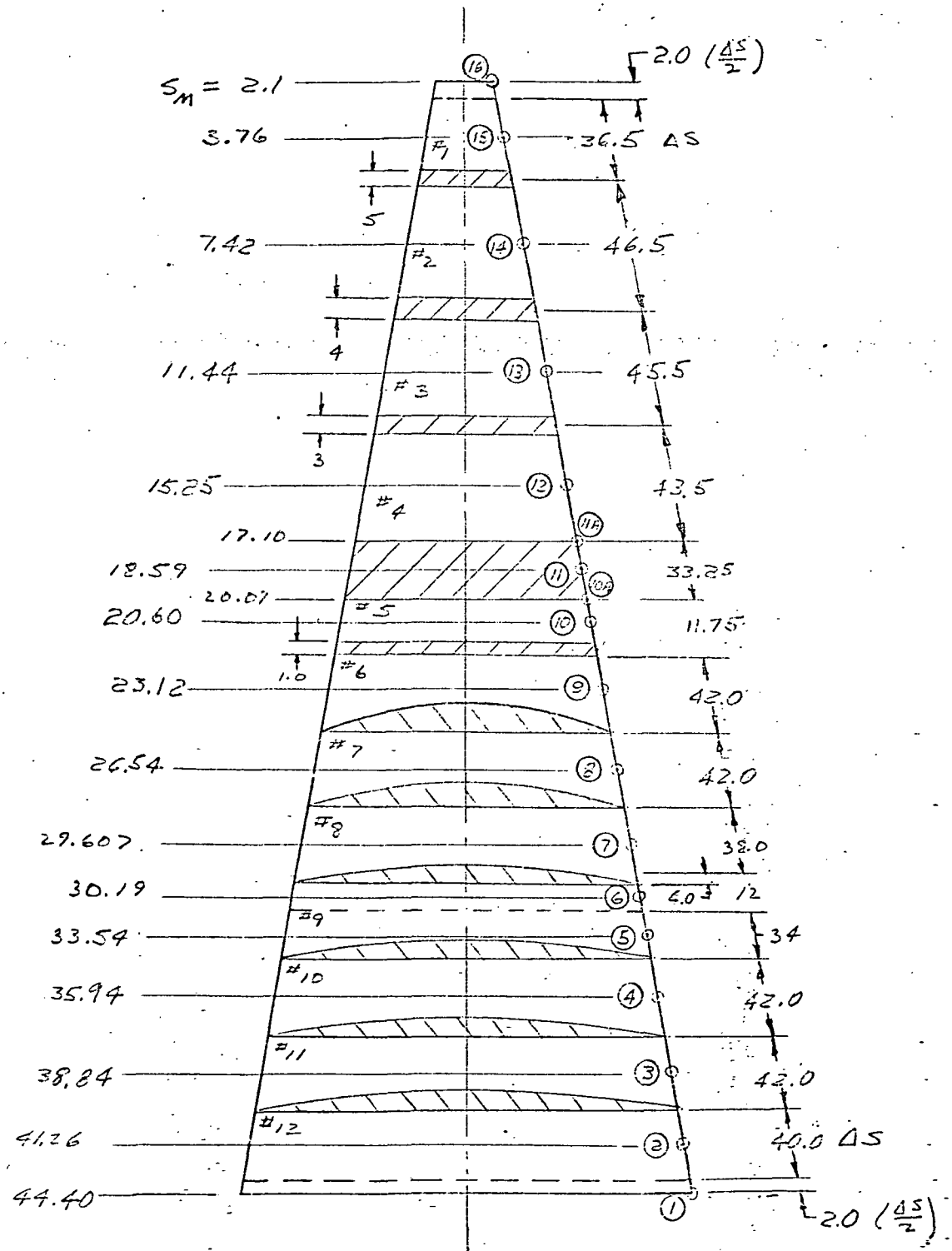
DATE 10/4/67		MODEL NO.

GORE GEOMETRY



#SAIL NUMBERS

FORM 30-381 (N. 12-66)

W. MULLINS PREPARED	NORTHROP VENTURA	A4 PAGE NO. OF
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DATE 9/15/67		MODEL NO.

SAIL STIFFNESS

STA.	CONSTRUCTION	ΔS	RATED STRENGTH	BS LB/IN	
1	2-1200 LB TAPES 2.0 IN. 42 LB CLOTH	2.0	2400 84	1242	SKIRT BAND
2	40 IN. 42 LB CLOTH	40	1650	42	SAIL 12
3	42 IN. 42 LB CLOTH	42	1764	42	SAIL 11
4	42 IN 42 LB CLOTH 200 LB TE TAPE	42	1764 200	46.8	SAIL 10
5	38 IN 42 LB CLOTH	38	1596	42	SAIL 9
6	2-1200 LB TAPE 90 LB TAPE 4 IN. 42 LB CLOTH	4	2400 90 168	665	
7	42 IN 42 LB CLOTH 90 LB LE TAPE 200 LB MID TAPE 200 LB TE TAPE	42	1764 90 200 200	53.7	SAIL 8
8	42 IN 42 LB CLOTH 90 LB LE TAPE 200 LB MID TAPE 350 LB TE TAPE	42	1764 90 200 350	57.2	SAIL 7
9	42 IN 42 LB CLOTH 90 LB LE TAPE 200 LB. MID TAPE 350 LB. TE TAPE	42	1764 90 200 350	57.2	SAIL 6
10	11.25 IN 42 LB CLOTH 200 LB LE TAPE 1200 LB TE TAPE 625 LB TE TAPE	11.75	472 200 1200 625	213	SAIL 5

FORM 30-381 (N. 12.66)

W. MULLINS PREPARED	**NORTHROP VENTURA**	A.5 PAGE NO. OF
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DATE 10/4/67		MODEL NO.

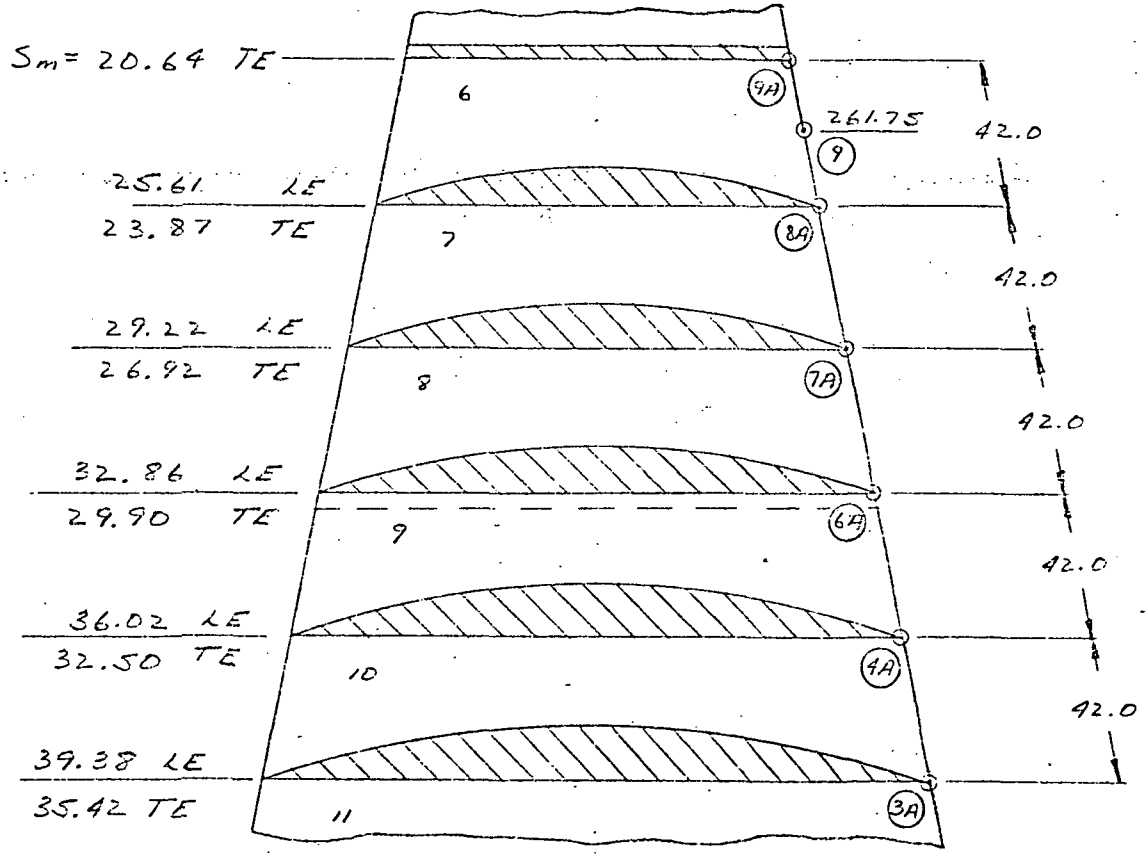
SAIL STIFFNESS (CONTD)

STA	CONSTRUCTION	ΔS	RATED STRENGTH	BS LB/IN	
11	OPEN	33.25	0	0	SLOT
12	42 IN 90 LB CLOTH 350 LB LE TAPE 200 LB TE TAPE	43.5	3780 350 200	99.5	SAIL 4
13	42 IN 90 LB CLOTH 200 LB LE TAPE 200 LB TE TAPE	45.5	3780 200 200	91.9	SAIL 3
14	42 IN 90 LB CLOTH 200 LB LE TAPE 200 LB TE TAPE	46.5	3780 200 200	89.9	SAIL 2
15	34 IN 90 LB CLOTH 200 LB LE TAPE	36.5	3060 200	89.3	SAIL 1
16	40 IN 90 LB CLOTH 4000 LB WEB 1200 LB TAPE	2.0	360 4000 1200	2780	VENT BAND

FORM 30-381 (N. 12-66)

W. MULLINS PREPARED	**NORTHROP VENTURA**	A6 PAGE NO. OF
CHECKED		REPORT NO.
DATE 10/4/67		MODEL NO.

GORE GEOMETRY (CONT'D)

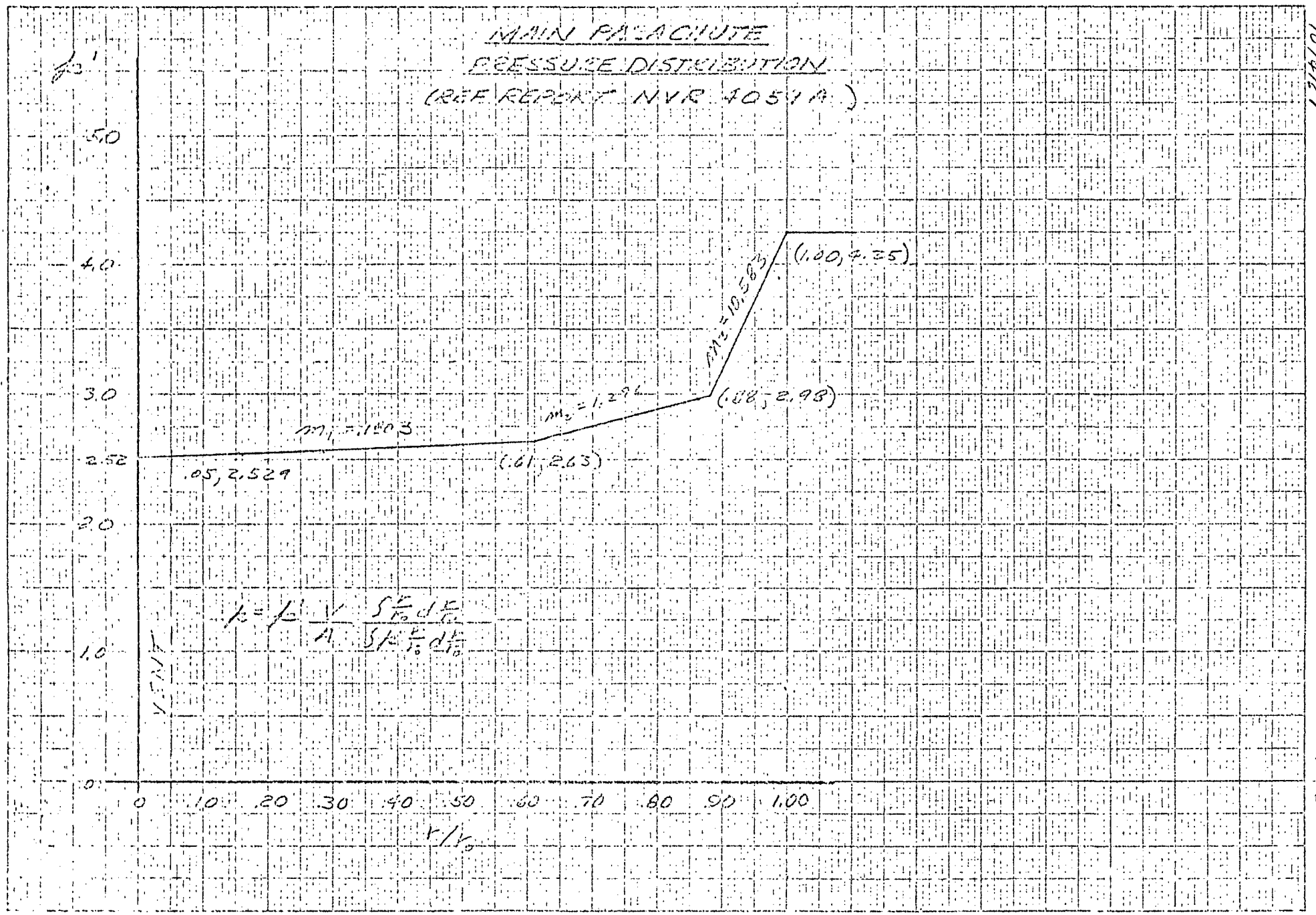


FORM 30-381 (N. 12-66)

W. MULLINS PREPARED	**NORTHROP VENTURA**	A7 PAGE NO. OF
CHECKED		REPORT NO.
DATE 10/4/67		MODEL NO.

SAIL STIFFNESS -

STA.	CONSTRUCTION	ΔS	RATED STRENGTH	BS lbs/in.	SAIL
3AL	21 in 42 lb. CLOTH	21	882	42	10 LE
4AT	21 in 42 lb. CLOTH 200 lb TAPE	21	882 200	51.5	10 TE
4AL	21 in 42 lb CLOTH	21	882	42	9 LE
6AT	21 in 42 lb. CLOTH 2-1200 lb. TAPE 90 lb. TAPE	21	882 2400 90	160	9 TE
6AL	21 in 42 lb. CLOTH 90 lb. TAPE ½ OF 200 lb. MID TAPE	21	882 90 100	51	8 LE
7AT	21 in 42 lb. CLOTH 200 lb. TAPE ½ OF 200 lb. MID TAPE	21	882 200 100	56.28	8 TE
7AL	21 in 42 lb. CLOTH 90 lb. TAPE ½ OF 200 lb. MID TAPE	21	882 90 100	51	7 LE
8AT	21 in 42 lb. CLOTH 350 lb. TAPE ½ OF 200 lb. MID TAPE	21	882 350 100	63.4	7 TE
8AL	21 in. 42 lb. CLOTH 90 lb. TAPE ½ OF 200 lb. MID TAPE	21	882 90 100	51	6 LE
9AT	21 in. 42 lb. CLOTH 350 lb. TAPE ½ OF 200 lb. MID TAPE	21	882 350 100	63.4	6 TE


MAIN PARACHUTE
PRESSURE DISTRIBUTION
(REF REPORT NWC 4051 A)
C_p
5.0
4.0
3.0
2.52
2.0
1.0
0
(1.00, 4.25)
$m_3 = 10.58$
(.88, 2.98)
$m_2 = 1.296$
(.61, 2.63)
$m_1 = .1203$
(.05, 2.529)
$C_p = C_{p_1} \frac{1}{A} \frac{\int \frac{r}{r_0} d\frac{r}{r_0}}{\int \frac{r}{r_0} d\frac{r}{r_0}}$
.10
.20
.30
.40
.50
.60
.70
.80
.90
1.00
r/r_0

CANOPY LOADS

W. MULLINS — PREPARED — DATE 10/4/67 — CHECKED

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
SECTIONS	R_i	RADIAL TAPE STRENGTH	P_R	$\Delta S'$	ϵ_R	$\Delta\phi/2$	ϕ	r	f_2	ψ	N_ψ	
	$V\frac{\sin\phi}{M} \Big/ \phi - N_2 \sin\phi / r$		$\frac{V}{M\sin\phi}$	(PG A3	(CURVE FG. D5-5) (REF 1)	$\frac{\Delta S(1+\epsilon_R)}{2R_i}$	$\phi_{(i-1)} - \frac{\Delta\phi_{(i-1)}}{2} - \frac{\Delta\phi_i}{2}$	*	(PG A3	**	$\frac{f_2 \sin\psi}{\sin\psi}$	
	IN.	LB	LB	IN.	IN/IN.	°	°	IN.	PSI	°	LB/IN.	
1	155	700	624	4	.202	.8883	104.31	432.0	.106	45.8	2.9	
2	156	↓	624	40	.202	8.816	94.427	436.25	.106	33.4	3.9	
2 AT								436.26	.106	22.3	5.6	
2 AL								436.26	.106	45.8	3.0	
3	164		610	42	.198	5.786	76.324	432.43	.106	20.7	6.0	
3 AT								424.84	.102	13.13	8.8	
3 AL								424.84	.102	27.9	4.3	
4	206		591	42	192	6.153	61.075	414.09	.095	10.9	9.6	
4 AT		↓						404.68	.087	3.36	27.4	
4 AL		700						404.68	.087	18.0	5.2	

M = NUMBER OF GORES = 60

** SELECT ψ TO SATISFY $\frac{\psi}{\sin\psi} = \frac{2\pi(1+\epsilon_R)}{2\pi \cdot \sin\psi_M}$

* $r = r_{(i-1)} - [R_i \cos\phi (\sin\frac{\Delta\phi}{2})]_{(i-1)} - [R_i \sin\phi (1-\cos\frac{\Delta\phi}{2})]_{(i-1)} - R_i \cos\phi (\sin\frac{\Delta\phi}{2}) + R_i \sin\phi (1-\cos\frac{\Delta\phi}{2})$

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REPORT NO.

MODEL NO.

CANOPY LOADS (CONTD)

REV 10/27/67

W MULLINS — PREPARED — CHECKED — DATE 10/4/67

CONFIDENTIAL — MODEL NO. — REPORT NO. — PAGE NO. 410 — OF

STATION	(13) $BS_{(1+\epsilon_s)}$	(14) S_M	(15) E_s	(16) A	(17) V	(18) N_θ	( )	( )	( )	( )	( )	( )
	(PG 14)	(PG A3)	(FROM CURVES REF 1)	*	$V_{(A-1)} - (A_{(A-1)} - A)\left(\frac{A_A + A_{(A-1)}}{2}\right)$	$N_\psi \cos(\psi - \alpha)$						
	LB/IN	IN.	IN/IN.	IN^2	LB	LB/IN.						
1	1033	44.4	0	600800	41200	2.1						
2	34.9	41.26	.034	608200.	41970	3.3						
2 AT	35.0	39.42	.048									
2 AL	35.0	43.75	.026									
3	35.1	38.84	.051	593100	40360	5.6						
3 AT	35.1	35.42	.072									
3 AL	35.1	39.38	.037									
4	39.3	35.94	.071	540700	35100	9.5						
4 AT	43.3	32.50	.151									
4 AL	35.3	36.02	.045									

$$^*A = \frac{M}{2}(2\psi - \sin 2\psi)\left[\frac{S_M(1+\epsilon_s)}{2\psi}\right]^2 + \frac{Mr^2}{2}\sin\frac{2\pi}{M}$$

$\alpha = \sin^{-1}(\sin\psi \sin\frac{\pi}{M})$

FORM 30-331 (N. 12-65)

CANOPY LOADS

STATION	(1) R_1 $\frac{V/\frac{\pi}{180}\sin\phi}{\lambda - \frac{N_0 \sin\phi}{r}}$ IN.	(2) RADIAL TAPE STRENGTH LB	(3) P_R $\frac{V}{M \sin\phi}$ LB	(4) $\Delta S'$ (PG) IN.	(5) ϵ_R (CURVE FIG. D5-5) (REF 1) IN/IN.	(6) $\Delta\phi/2$ $\frac{\Delta S'(1+\epsilon_R)}{2R_1}$ °	(7) ϕ° $\phi(\lambda-1) - \frac{\Delta\phi}{2}(\lambda-1) - \frac{\Delta\phi}{2}$ °	(8) r * IN.	(9) f_2 (PG A 8) PSI	(10) ψ ** °	(11) N_ψ $\frac{\Delta r \sin\frac{\pi}{M}}{\sin\psi}$ LB/IN.	(12)
5	257	700	567	34	.185	4.492	49.62	388.25	.079	9.0	9.0	
6	-369	↑	527	12	.174	-1.014	46.22	369.68	.074	1.22	59.1	
6 AT								369.67	.074	1.22	59.1	
6 AL								369.67	.074	11.0	6.6	
7	379		478	38	.160	3.331	43.98	349.46	.072	4.0	16.6	
7 AL								333.17	.072	7.5	8.4	
7 AT								333.17	.071	2.1	30.0	
8	398		423	42	.144	3.458	37.19	314.48	.069	3.37	17.1	
8 AT		↓									31	
8 AL		700						294.92	.068	5.3	10.0	

M = NUMBER OF GORES = 60

** SELECT ψ TO SATISFY $\frac{N_\psi}{\sin\psi} = \frac{\frac{1}{2}\rho g (1+\epsilon_R)}{2f - \sin\psi\frac{N_\psi}{r}}$

$$r = r_{(\lambda-1)} - \left[R_1 \cos\phi \left(\sin\frac{\Delta\phi}{2}\right)\right]_{(\lambda-1)} - \left[R_1 \sin\phi (1-\cos\frac{\Delta\phi}{2})\right]_{(\lambda-1)} - R_1 \cos\phi \left(\sin\frac{\Delta\phi}{2}\right) + R_1 \sin\phi (1-\cos\frac{\Delta\phi}{2})$$

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PROJECT PARAFOIL TECHNOLOGY
MODEL NO.
REPORT NO.
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CANOPY LOADS (CONTD)

STATION	(13) $BS/(1+\epsilon_s)$ (EQ 1.4) LB/IN	(14) S_M (FIG A3) IN.	(15) ϵ_s (FROM CURVES REF 1) IN/IN.	(16) A * IN^2	(17) V $V_{(n-1)} - (A_{(n-1)} - A)\left(\frac{n+1}{2}\right)$ LB	(18) N_θ $N_\psi \cos(\psi-\alpha)$ LB/IN.	( )	( )	( )	( )	( )	( )
5	35.4	33.54	.074	474100	29340	9.0						
6	200.1	30.19	.131	428900	25950	59.1						
6 RT	136.3	29.90	—									
6 AL	43.4	32.86	.046									
7	51.1	29.61	.091	383700	22560	16.6						
7 RT	18.9	26.92	.165									
7 AL	14.3	29.22	.056									
8	50.0	26.54	.095	310600	17390	17.1						
8 RT	15.1	23.87	.166									
8 AL	14.9	25.61	.065									

$$^{*}A = \frac{M}{2}(2\psi - \sin 2\psi)\left[\frac{S_M(1+\epsilon_s)}{2\psi}\right]^2 + Mr^2 \sin\frac{\pi}{m}$$

$\alpha = \sin^{-1}(\sin\psi \sin\frac{\pi}{m})$

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CHECKED
DATE 10/4/67

REPUBLIC AVIATION CORPORATION FARMINGDALE, NEW YORK

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MODEL NO.
REPORT NO.

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CF

FORM 30-321 (N. 12-66)

CANOPY LOADS

STATION	(1) R_1	(2) RADIAL TAPE STRENGTH	(3) P_x	(4) $\Delta S'$	(5) ϵ_R	(6) $\Delta\phi/2$	(7) ϕ	(8) r	(9) p	(10) ψ	(11) N_ψ	(12)
	$\frac{V/g\pi r \sin\phi}{p - \frac{N_0 \sin\phi}{r}}$		$\frac{V}{M \sin\phi}$	(PG A3	(CURVE A3.05-5) (REF 1)	$\frac{\Delta S(1+\epsilon_R)}{2R_1}$	$\phi_{(i-1)} - \frac{\Delta\phi_{(i-1)}}{2} - \frac{\Delta\phi}{2}$	*	(PG A8)	**	$\frac{p_r \sin\frac{\pi}{N_\psi}}{\sin\psi}$	
	IN.	LB	LB	IN.	IN/IN.	°	°	IN.	PSI	°	LB/IN.	
9	430	700	360	42	.126	3.15	30.00	274.90	.066	2.67	18.2	
9 AT								254.23	.065	2.60	30.0	
10	1+16		312	11.75	.108	.264	27.17	249.25	.065		35.6	
10A	—		291	0	.108	0	26.90	242.61	.065	2.5	35.	
11	∞		291	33.25	.108	0	26.90	224.19	0		—	
11A	—		291	0	.108	0	26.90	205.8	0	.95	37.2	
12	450		285	42.5	.094	3.075	23.83	186.73	.0648	—	29.1	
13			253	45.5	.092	3.189	17.56	139.65	.0613	—	29.3	
14			195	46.5	.076	3.210	11.16	89.71	.0538	—	29.3	
15			133	36.5	.057	2.473	5.43	41.35	.0624	—	28.9	
16	----	700	85	4.0	.038	—	2.73	22.25	.0620	—	—	

M = NUMBER OF GORES = 68 ** SELECT ψ TO SATISFY $\frac{N_\psi}{\sin\psi} = \frac{\text{SMALLEST}}{\text{SIN}\frac{\pi}{M}}$

$$* \quad r = r_{(i-1)} - \left[R_1 \cos\phi \left(\sin\frac{\Delta\phi}{2}\right)\right]_{(i-1)} - \left[R_1 \sin\phi \left(1-\cos\frac{\Delta\phi}{2}\right)\right]_{(i-1)} - R_1 \cos\phi \left(\sin\frac{\Delta\phi}{2}\right) + R_1 \sin\phi \left(1-\cos\frac{\Delta\phi}{2}\right)$$

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DATE 10/4/67

PROJECT NO.

MODEL NO.

A13 — PAGE NO. — OF

CANOPY LOADS (CONT'D.)

PREPARED W. MULLINS DATE 10/4/67 CHECKED

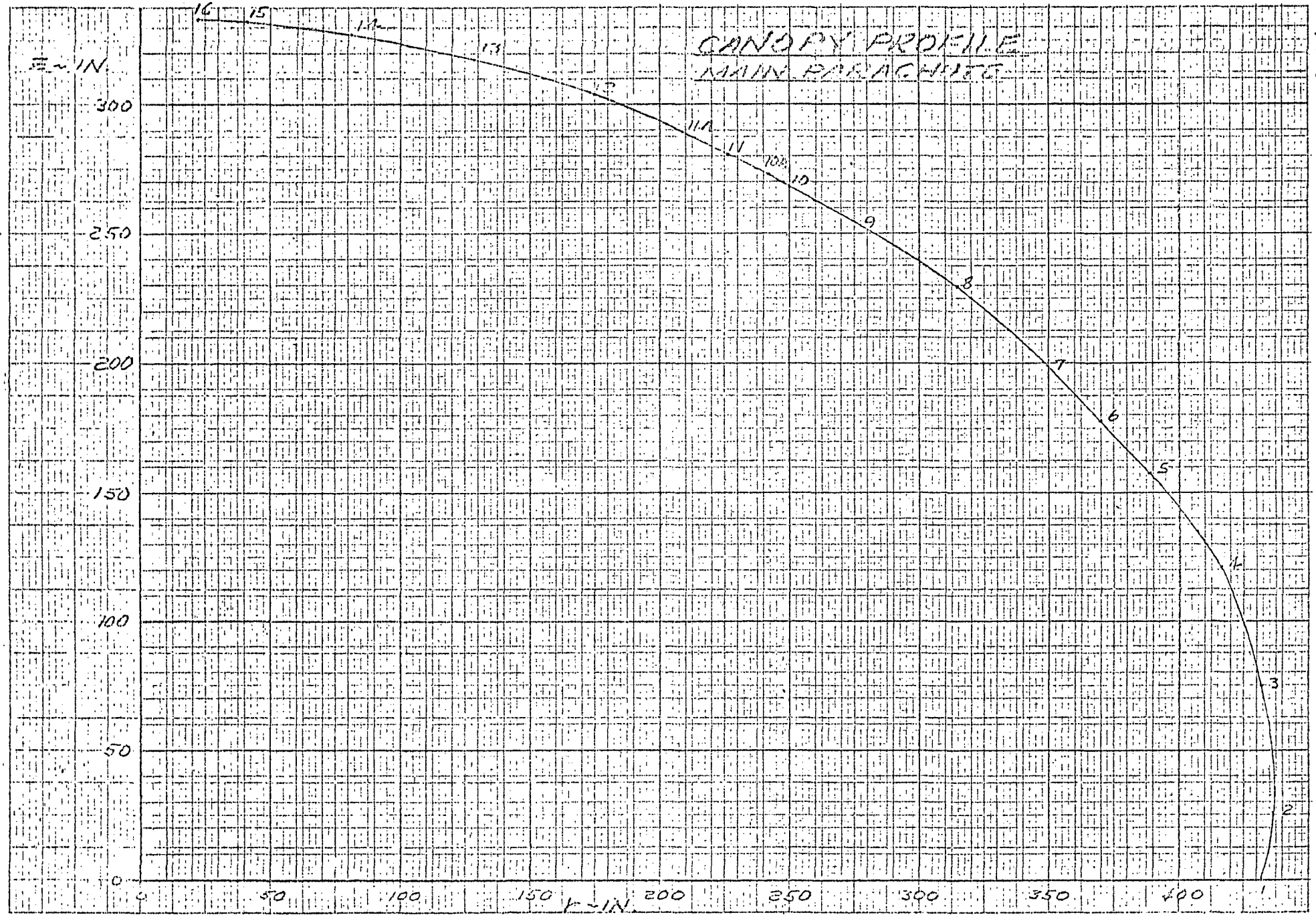
STATION	(13) $BS/(1+\epsilon_s)$ (PG A4.) LB/IN	(14) S_M (PG A3) IN.	(15) ϵ_s (FROM CURVES REF 1) IN/IN.	(16) A * IN^2	(17) V $V_{(n-1)} - (A_{(n-1)} - A)\left(\frac{\alpha + \alpha_{(n-1)}}{2}\right)$ LB	(18) N_ψ $N_\psi \cos(\psi - \alpha)$ LB/IN.	( )	( )	( )	( )	( )	( )
9	50.9	23.12	.099	237300	12420	13.1						
9 AT	56.7	20.64	.138									
10	191.5	20.60	.114	193700	9540	35.6						
10A	236.0	20.07	.116	184730	8960	35						
11	—	—		16000	8960	0						
11A	90.0	17.1	.129	137080	8960	37.2						
12	90.1	15.25	.131	109410	7170	29.1						
13	83.9	11.4	.131	61190	4030	29.3						
14	83.3	7.42	.117	25250	1750	29.3						
15	84.2	3.76	.132	6170	550	28.9						
16	26.8	2.10	0	1552	0	—						

$$^{*}A = \frac{M}{2}(2\psi - \sin 2\psi)\left[\frac{S_a \cdot V}{2\psi}\right]^2 + Mr^2 \sin\frac{2\pi}{m}$$

$\alpha = \sin^{-1}(\sin\psi \sin\frac{\pi}{m})$

PROJECT NO. [illegible] REPORT NO. MODEL NO. PAGE NO. A14

FORM 30.291 (N. 12-66)



KEUFFEL & ESSER CO.

10/2/67

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 21

Recommended Change:

Revise either R8120 drogue riser clevis or R8122 drogue riser bushing mating length.

Reason:

The drogue riser bushing could be 0.040 longer than the clevis mating length based on present dimensions.

Action:

Problem was corrected by drawing revision ADCN A-2 of drogue riser clevis P/N R8120 which reduced the possible tolerance on the clevis dimension mating with the bushing.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 22

Recommended Change:

1. Increase 0.040 chamfer on drogue riser clevis P/N R8120 or decrease size of 0.040 R on mating end fitting of drogue metal riser assembly R8109.

2. Decrease 0.040 R on flowerpot end of drogue riser cable P/N R8109.

3. Add proof load to drogue riser cable.

Reason:

1. Potential interference between cable end fitting and clevis in this area due to tolerance.

2. The radius is outside the specified envelope.

3. To verify integrity of swage.

Action:

1. ADCN A3 against drogue riser clevis P/N R8120 limits the chamfer to 0.040 to 0.050. ADCN A2 against drogue metal riser P/N R8109 limits the mating radius to 0.030 to 0.040.

2. Included in original release of drawing. P/N R8109 drogue riser assembly. Radius reduced to 0.020 - 0.010 R.

3. Included in Test Procedure 6216 invoked by note 9 of drawing P/N 8109 drogue riser assembly.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 25

Recommended Change:

2. Revise drogue mortar restrictor P/N R8114 to show -9 nylon insert protruding.

Reason:

This will assure that the nylon insert will not be cut off after installation.

Action:

The nylon locking insert was deleted and Locktite is applied to these threads at assembly. Drogue mortar restrictor P/N R8114 ADCN A2 deleted the -9 nylon inserts. The original release of drogue mortar tube assembly P/N R8107 included a requirement for the application of Locktite on the restrictor to breech thread.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 26

Recommended Change:

On drogue mortar cover P/N R8119 replace the 1.150 and 1.770 dimensions with one (1) edge dimensions.

Reason:

To reduce the number of dimensions.

Action:

Revision B-1 was released against drogue mortar cover P/N R8119. The revision added a 0.31 edge dimension but removed the 1.46 and 2.08 dimension instead of the 1.150 and 1.770 dimensions.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 27

Recommended Change:

Coordinate dimensioning of groove of drogue shear pin P/N R8111 with wall thickness of drogue mortar tube P/N R8108.

Reason:

To assure that the shear pin groove is at the cover to tube joint. That the proper portion of the pin is subjected to the shear load.

Action:

A dimensional analysis was performed using the latest drawings. The dimensions of the tube wall and the shear pin will assure proper function of the shear pin.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 28

Recommended Action:

Revise method of dimensioning the drogue riser nut assembly P/N R8128. Replace the 0.125 dimension with a 0.295 from other face of part.

Reason:

To improve tolerance control of assembly thread engagement.

Action:

A dimensional analysis was performed. The study indicates there is no problem with the amount of thread engagement. The change made to P/N R8120 clevis (see DRAR No. 21) will reduce the possible variation in length of thread engagement.

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 29

Recommended Change:

Revise the drogue mortar tube P/N R8108 as follows:

1. Add a match note for 6 inserts "to match R8113".
2. Change dimensions 6.994 and 10.616 to reference or code for tooling information.
3. Code dimension 9.284/9.278 critical.
4. Add a countersink requirement to tapped holes.
5. Delete one of two 7/32 diameter holes.
6. Code dimension 0.060 min. (wall thickn ess) major.
7. Replace Helicoil inserts with Keenserts.
8. Clarify dimensions of upper end (12.260 MAX, 12.125/12.135 ID, 0.060 min).

Reason:

1. Clarify drawing, manufacturing information.
2. Clarify drawing, manufacturing information.
3. Quality assurance information.
4. Easier to assemble.
5. Does not agree with specification control drawing.
6. Quality assurance information.
7. Customer request.
8. To assure proper wall thickness at upper end.

Action:

1., 2., 3., 6., 7. and 8. Drawing R8108 DCN B includes these changes.

4. None, a standard requirement for countersinking tapped holes is in thread specification 16-25-00.

5. See DRAR 6(d).

NORTHROP VENTURA
APOLLO INCREASED CAPABILITY PROGRAM

DRAR No. 30

Recommended Change:

NAA approves the following drawings in accordance with CDR proceedings:

R8110-1 - Except N/A calls out only one end item.
R8107-1
R8117-1
R8118-1
R8121-1
R8123-1
R8157-1
R8156-1
DR8115-1) Approved providing R Dwg identical to
DR8112-1) these review copies.
R8108 - Approved unless NV is notified in 7 days and provided upper end wall thickness is clarified and provided DAR 29, 1-6, is incorporated.
R8114 - Provided -9 insert is eliminated.
R8119 - Provided shear hole dimensions are revised to reduce one call out.
R8128 - Provided dimensions are revised.

Action:

See attached Change Directive No. 0107-040.

CHANGE DIRECTIVE

NORTHROP VENTURA

No. 0107 (PROJECT) 040 (DIRECTIVE) ___ (DASH)

CHANGE CLASS: B	☐ EMERGENCY ☐ URGENT ☒ ROUTINE ☐ COMPATIBILITY	☒ AUTHORIZED ☐ PARTL. AUTH. ☐ INFO. ONLY	TITLE: APOLLO BLK II INCREASED CAPACITY - BASELINE CONFIGURATION			DATE: 9/12/67	PAGE: 1 OF 4
☒ WITHIN SCOPE ☐ OUT OF SCOPE	CRAD: BII	EWR NO.	MULTI-USE CHANGE: ☐ YES ☒ NO	REWORK REQUIRED: ☐ YES ☒ NO	RETROFIT REQ'D: ☐ YES ☒ NO	PREPARED: BOEING CO.	
ENGR. STOP REQ'D: ☐ YES ☒ NO	REFERENCES (REQ - ECP - RCA - TWX - ETC.): CDR ON 9/13/67 DRAB #30					ORGANIZATION: 2150	EXTENSION: 511
							PROJECT CLASS:

DESCRIPTION OF CHANGE (DESCRIBE TOTAL IMPACT OF CHANGE) — REV. LTR.

1) ESTABLISH A BASELINE CONFIGURATION FOR APOLLO BLK II ELS (DROGUE & MAIN)

(OLD DWG WAS IN ERROR, AS HAND ISSUED & IN CDR MTG, DATED 9/13/67)

2) MAKE A STATUS LIST, AND EXPLANATORY CHG, SUMMARIZING TOTAL PHASE II DOCS AFFECTED STATUS, AND PLANNED FOLLOWING DATES FOR REMAINING BOARDS.

REASON FOR CHANGE (WHAT WILL CONSEQUENCES BE IF CHANGE IS NOT MADE?)

CRITICAL DESIGN REVIEW REQUIREMENT & SUBSEQUENT DOUBLE CHECKING OF 1ST BASELINE.

PART/DOCUMENT NUMBER: EXISTING	PART/DOCUMENT NUMBER: CHANGE TO	DOCUMENT: NUMBER	DOCUMENT: REV.	SCHED. OFF BOARD DATE	IDENTIFICATION AND NOMENCLATURE	EFFECTIVITY: TYPE	EFFECTIVITY: NUMBERS AFFECTED
							Record
SEE P. 2, 3, 4							

REMARKS & SPECIAL REFERENCES

1) ITEMS NOTED BY (*) WERE APPROVED BY DRAB #30
2) ITEMS NOTED BY (Δ) WERE PRIOR APPROVED ON BLK I AND for BLK II

P.O. TO BOEING FROM V. BOARDS ASSY.

REF. COR NO. 064

- ☐ CONTRACT PRICE
- ☐ DELIVERY SCHEDULE
- ☐ SAFETY
- ☐ WEIGHT
- ☐ RELIABILITY
- ☐ PERFORMANCE
- ☐ INTERCHANGEABILITY
- ☐ SPARES ☐ EXHIBITS
- ☐ TEST PROCEDURE
- ☐ OTHER ___

C.D. REQUEST APPROVALS

BA Boehm

MASTER SCHEDULE NUMBER

REV. LTR.	AUTHORIZED SIGNATURE	DATE

APPROVALS

PROJECT: [signature] DATE 9/12/67

SCHEDULES: [signature] DATE 9/12/67

CCB CHAIRMAN APPROVAL

NAME [signature]

DATE 9/12/67

CHANGE DIRECTIVE

CONTINUATION SHEET

NORTHROP VENTURA

No. ____ PROJECT ____ DIRECTIVE ____ DASH

CHANGE CLASS: ☐ EMERGENCY ☐ URGENT ☐ ROUTINE ☐ COMPATBLTY | ☐ AUTHORIZED ☐ PARTL. AUTH. ☐ INFO. ONLY

TITLE

DATE

PREPARED BY

PART/DOCUMENT NUMBER			DOCUMENT		SCHED. OFF BOARD DATE		IDENTIFICATION AND NOMENCLATURE	EFFECTIVITY	
EXISTING	CHANGE TO		NUMBER	REV.				TYPE	NUMBERS AFFECTED
			R8058-503				PACK ASSY - MAIN		
		Δ	R7122-515				WARNING TAG		
		Δ	R7749-3				BUFFER		
		Δ	R7869-1				BREAK CORD		
			R8102-1				REEFING LINE		
PACK ASSY MAIN CHUTE			R8102-3				REEFING LINE		
			R8125-1				REEFING LINE		
			58516-6				REEFING CUTTER		(6 SEC)
			58517-10				REEFING CUTTER		(10 SEC)
ME 623-0007 -0001			R7541-551				PARACHUTE ASSY - MAIN		
		Δ	R7148-1				PROTECTOR		
		Δ	R7666-1				LINK		
		Δ	R8061-1				RISER		
			R7661-519				PARACHUTE		
		Δ	R7827-1				POCKET, REEFING CUTTER		
			R7827-501				POCKET, REEFING CUTTER		
			R8127-1				REEFING RING		
		Δ	NV-STD 243-1				REEFING RING		
		Δ	R8080-501				DEPLOYMENT BAG, MAIN		
		Δ	R8082-1				BRIDGE		
		Δ	R8089-1				FLAP		
		Δ	R8089-3				FLAP		
		Δ	R8089-5				FLAP		
		Δ	R8081-1				SIDE FLAP ASSY		
		Δ	R8081-3				SIDE FLAP ASSY		
		Δ	R8081-5				SIDE FLAP ASSY		
		Δ	R7700-501				TAG, IDENTIFICATION		

REMARKS & SPECIAL REFERENCES

CHANGE DIRECTIVE

CONTINUATION SHEET

NORTHROP VENTURA

No. PROJECT DIRECTIVE DASH

CHANGE CLASS: ☐ EMERGENCY ☐ URGENT ☐ ROUTINE ☐ COMPATBLTY | ☐ AUTHORIZED ☐ PARTL. AUTH. ☐ INFO. ONLY

TITLE

DATE

PAGE 2 OF 4

PREPARED BY

PART/DOCUMENT NUMBER		DOCUMENT		SCHED. OFF BOARD DATE	IDENTIFICATION AND NOMENCLATURE	EFFECTIVITY	
EXISTING	CHANGE TO	NUMBER	REV.			TYPE	NUMBERS AFFECTED
					R8110-1 MORTAR ASSEMBLY, DROGUE		
					R8107-1 TUBE ASSEMBLY, DROGUE MORTAR		
					R8108-1 TUBE, DROGUE MORTAR		
					R8124-1 TUBE, ROUGH		
				✲	R8113-1 BREECH, DROGUE MORTAR		
					R8114-1 RESTRICTOR, DROGUE MORTAR		
MORTAR ASSY	ASSY				R8115-1 ORIFICE, DROGUE MORTAR		
DROGUE CHUTE	CHUTE				R8116-1 SABOT ASSEMBLY, DROGUE MORTAR		
				✲	R8117-1 SABOT, DROGUE MORTAR		
ME6A3-0008-				✲	R8118-1 SEAL, DROGUE MORTAR		
	-0001				R8119-1 COVER, DROGUE MORTAR		
					R8112-1 RING, FOAMED RISER, DROGUE		
					R8109-1 RISER ASSEMBLY, DROGUE METAL		
					R8120-1 CLEVIS, DROGUE RISER		
				✲	R8121-1 TERMINAL, DROGUE RISER		
					R8122-1 BUSHING, DROGUE RISER		
				✲	R8123-1 WASHER, DROGUE RISER		
					R8128-1 NUT ASSEMBLY		
					R8111-3 PIN, SHEAR, DROGUE MORTAR		
					R8157-501 PACK ASSEMBLY, DROGUE		
				✲	R8156-1 DEPLOYMENT BAG, DROGUE		
					R8155-501 PARACHUTE ASSEMBLY		
				△	R7827-1 POCKET, REEFING CUTTER		
				△	R6848-47 CORD		
REMARKS & SPECIAL REFERENCES				△	R6848-49 BREAK CORD		
				△	R6848-51 BREAK CORD		
					R6848-179 REEFING LINE		

NS FORM 30-203C (5-65)

CHANGE DIRECTIVE

CONTINUATION SHEET

NORTHROP VENTURA

No. PROJECT DIRECTIVE DASH

CHANGE CLASS: ☐ EMERGENCY ☐ URGENT ☐ ROUTINE ☐ COMPATIBLTY | ☐ AUTHORIZED ☐ PARTL. AUTH. ☐ INFO. ONLY

TITLE

DATE

PREPARED BY

PART/DOCUMENT NUMBER		DOCUMENT		SCHED. OFF BOARD DATE	IDENTIFICATION AND NOMENCLATURE	EFFECTIVITY	
EXISTING	CHANGE TO	NUMBER	REV.			TYPE	NUMBERS AFFECTED
					R6848-181 REEFING LINE		
D80G08	(CONT)		Δ		R7122-513 WARNING TAG		
			Δ		58448-8 REEFING CUTTER		
			Δ		R6004 B/N NAMEPLATE		
			Δ		R6006 B/N NAMEPLATE		

REMARKS & SPECIAL REFERENCES